AN EXPERIMENTAL STUDY OF IMPELLER SYSTEM WITH LIMITED RPM USING PEDAL MECHANISM

S.P.Kamanwar[1], K.N.Wagh[2]

[1]*M-tech Student, Mechanical Engineering Department, Guru Nanak Institute of Technology, Nagpur, India.*
[2]*Asst. Professor, Mechanical Engineering Department, Guru Nanak Institute of Technology, Nagpur, India.*

ABSTRACT

As per the technical evolution and latest technological trends taken into consideration so here effectively created an optimistic system i.e. ***"An Experimental Study of Impeller System with Limited RPM Using Pedal Mechanism" without using electricity."*** *The manufacturing of this project is followed by using Human Power and available resources taken into consideration so that this will be helpful for common man in their daily life. This project works on the human power so that there is no utilization of any electricity. This project can be useful in the agricultural area to provide water supply to plants where electricity is not available. This project can be use where there is requirement to lift water towards overhead tank for any relevant application. This projects works on the bicycle pedal gear and related setup. Initially with the use of basic things available with us that are Driver i.e. front Sprocket pedal gear, driven element i.e. Sprocket gear and chain. In this project, pumping of water done by centrifugal pump which is created according to water movement should at the top and inlet at the bottom level so that water can be able access from anywhere and able to lift at the top of the building while creation of this vacuum creation is very much important task which is taken into consideration.*

Keyword: *Hybrid impeller, Pedestal bearing, Round flange, mounted bearing.*

INTRODUCTION

This projects works on the bicycle pedal gear and related setup. Initially with the use of basic things available with us that are Driver i.e. front Sprocket pedal gear, driven element i.e. Sprocket gear and chain. In this project, pumping of oil, petrol and diesel done by centrifugal pump which is created according to oil, petrol and diesel movement should at the top and inlet at the bottom level so that oil, petrol and diesel can be able access from anywhere and able to lift at the top of the building while creation of this vacuum creation is very much important task which is taken into consideration. Centrifugal pumps are a sub-class of dynamic axis symmetric work-absorbing turbomachinery. Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy typically comes from an engine or electric motor. The fluid enters the Pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward into a diffuser or volute chamber (casing), from where it exits. There are basic three types of impeller which is described below. The efficiency of centrifugal pump is determined by impeller. Vanes are designed to meet a given range of flow condition.

Principle:

A consequence of Newton's second law of mechanics is the conservation of the angular momentum. This is of fundamental significance to all turbo machines. Accordingly, the change of the angular momentum is equal to the sum of the external moments. Angular momentums $\rho \times Q \times r \times cu$ at inlet and outlet, an external torque M and friction moments due to shear stresses $M\tau$ are acting on an impeller or a diffuser.

OPEN IMPELLER

Vanes are attached to the radial hub, without any form, sidewalls or shroud and are mounted directly onto a shaft. It is structurally weak and requires higher NPSHR value. It is used in small diameter, inexpensive pumps, and pumps handling suspended solids. It is more sensitive to wear than closed impeller.

CLOSED IMPELLER

The closed impeller has both a back and front wall for maximum strength. They are used in large pumps with high efficiency and low NPSAR. It has high wear rate. It is most widely used impeller in centrifugal pump handling clear liquid.

Experimental Method:

In this project, here used bicycle and centrifugal pump to lift water. There basic important units of the system.

1. Coupling Unit to carry Main ARM.
2. Main ARM.
3. Sub ARM.
4. Chain coupling between Main ARM and Sub ARM.
5. Centrifugal Unit
6. Inlet and outlet Piping Unit.

In the bicycle unit there are two arms.

A. Main Arm.
B. Sub Arm

Main ARM Consists of,

1. Driver: front Sprocket pedal gear.
2. Chain
3. Chain Wheel.
4. Crank Arm
5. Crank Bolt
6. Spider.
7. Chain ring Bolt.
8. Chain ring Teeth.

Sub ARM Consists of
1. Driven element: Sprocket gear.
2. Chain.

In this project the centrifugal pump rotation depends on the movement of main ARM and linking with the sub ARM via chain coupling. In this project here used bicycle i.e. human power to lift the water. This project suitably selected for common man who will use their own power and for that there will be no requirement of electricity. This project can be useful in agricultural area where there no availability of electricity. In this project here use Coupling Unit to carry Main ARM which is use to carry all following thing that are, Driver : front Sprocket pedal gear, Chain, Chain wheel, crank ARM, Crank Bolt, Spider, Chain Ring Bolt and Chain Ring Teeth. Ultimately the aligned movement of Main Sprocket gear depends on the Coupling Unit.

Main ARM uses following sub parts are as follows,
1. Driver: front Sprocket pedal gear.
2. Chain
3. Chain Wheel.
4. Crank Arm
5. Crank Bolt
6. Spider.
7. Chain ring Bolt.
8. Chain ring Teeth.

The Sprocket gear carries chain and pedal for the accessories used are chain wheel, crank ARM, Crank Bolt, Spider, chain ring bolt and chain ring teeth and finally all these assemblies mount over coupling unit. With the movement of pedal all assembly will
Start to rotate i.e. aligned movement of front sprocket gear and chain over coupling unit.

The Sub ARM consists of following unit as follows-

Sub ARM Consists of

1. Driven element: Sprocket gear.
2. chain

The movement of Sub ARM i.e. Driven element depends on Main ARM i.e. front Sprocket and linking chain. With the use of human power to rotate pedal accordingly Main sprocket and finally sub ARM.

The coupling mechanism uses Main ARM, Sub ARM, Chain Mechanism and Pedal. According to human force created that pedal movement depends on human power so accordingly front Sprocket gear will rotate. The RPM of sprocket gear will depends on human power. The basic RPM Human power will create more than RPM accordingly this RPM will transfer into in to front sprocket which is working as a driver to driven element with the help of chain coupling. The driven element consists of back sprocket. There are certain teeth available in the front sprocket and back sprocket we call it as sprocket teeth. Over that sprocket teeth chain has fixed having relevant slots according to sprocket teeth. The back sprocket is fixed over shaft of centrifugal pump and complete assembly mounted over bicycle and some relevant setup. The material used for the front sprocket is mild steel; impeller is made up of bead material and back sprocket made up of metal alloy. Complete assembly used for this made up of Iron.

Coupling Unit to carry Main ARM:

Here in this project used one impeller mechanism in that one impeller is place on bearing. The impeller is placed on the shaft. This complete assembly is human power based so that to rotate that impeller here used two different sprockets. One major sprocket as a driver and small sprocket as a driven element. The small sprocket is placed over shaft of impeller and driver sprocket is place again on shaft which is place on pedestal bearing. There is chain link between major sprocket and small sprocket.

Impeller fabrication is very much important for lifting of liquid towards overhead container. The designing and fabrication of impeller is created is according to type of liquid. There are many types of liquid i.e. water, oil, petrol, diesel, crude oil etc. In this project here used hybrid impeller so as to lift any liquid towards overhead container. In

this project here used advanced impeller with multiple blade arrangement for water lifting with thick dimensions shown above.

- ❖ Centrifugal Pump Machine Diameter : 13 cm
- ❖ Outer Periphery of Pump : 1.5 cm
- ❖ Core of Centrifugal Pump: 11.5.
- ❖ Impeller diameter of Centrifugal Pump : 11 cm
- ❖ Spacing between Impeller and core: 0.5 Cm.
- ❖ Shaft of impeller: 2 cm diameter.
- ❖ Fluid Outlet : 2.5 cm outer diameter
- ❖ Fluid Outlet : 2.45 cm inner diameter
- ❖ Fluid Inlet = 3 cm Outer diameter
- ❖ Fluid Inlet = 2.95 cm inner diameter.
- ❖ Speed of Impeller = 20 RPM Min
- ❖ No of Blades = 6

The impeller is placed inside and hollow cylinder. This cylinder is having ventilation for fluid outlet and fluid inlet. The ventilation for fluid inlet. This impeller is like curves shape so as to lift maximum liquid towards overhead container. The spacing between the impeller and hollow cylinder will decide the lifting of liquid towards overhead distance. The minimum spacing between the impeller and cylinder can able to lift up to maximum distance.

Calculation:

For Pedal RPM of 20RPM/Min

The study also identified an acceptable water velocity range from 3 to 10 m/s under the experimental conditions.

    A. For Pedal RPM = 20 RPM

The force transfer from **Pedal** to main Sprocket =   RPM of **Pedal** * 5

                               = 20RPM * 5 (Gear Reduction Value)

                               = 100 RPM of Main **Sprocket ARM**.

    B. For Main Sprocket RPM = 100 RPM

The force transfer from main **Sprocket** to Sub **Sprocket**   = RPM of Main **Sprocket** * 2

                              = 100 RPM * 2 (G. R. Value)

                            = 200 RPM of Sub **Sprocket** ARM.

    C. For Sub Sprocket RPM = 200 RPM

The force transfer from Sub **Sprocket** to Impeller = RPM of Sub **Sprocket /** 2

$$= 100 \text{ RPM} * 2 \text{ (G. R. Value)}$$

$$= 100 \text{ RPM of Impeller Shaft.}$$

D.   For RPM of Impeller = 5 * RPM of Pedal Shaft for time period of 20 sec
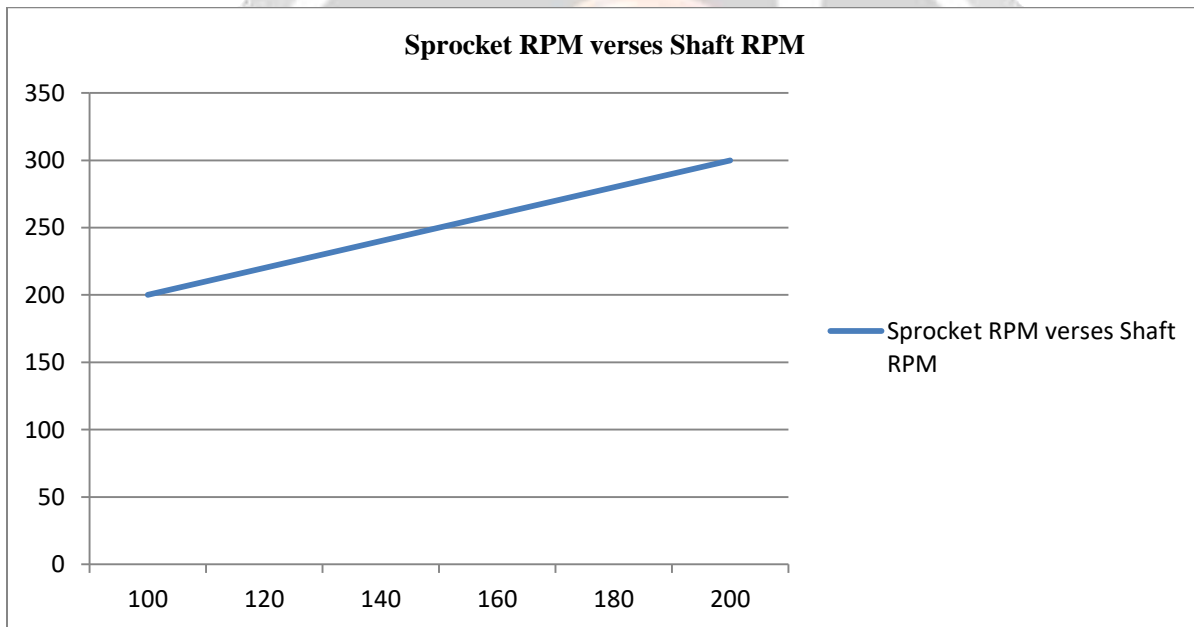
With head 72 inches

Pedal RPM verses Sprocket RPM:

Sr. No.	Pedal Rpm	Sprocket RPM
1	20	100
2	40	120
3	60	140
4	80	160
5	100	180
6	120	200
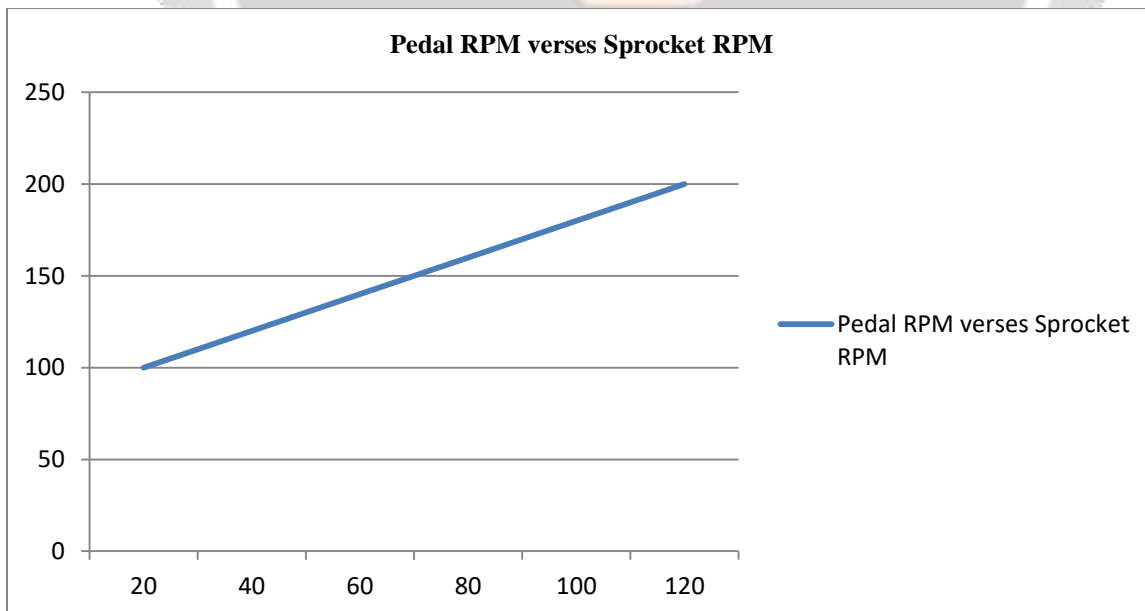
Sprocket RPM verses Shaft RPM

Sr. No.	Sprocket RPM	Shaft RPM
1	100	200
2	120	220
3	140	240
4	160	260
5	180	280
6	200	300

Shaft RPM verses Impeller RPM:

Sr. No.	Shaft RPM	Impeller RPM
1	200	100

2	220	120
3	240	140
4	260	160
5	280	180
6	300	200

Shaft RPM verses Impeller RPM
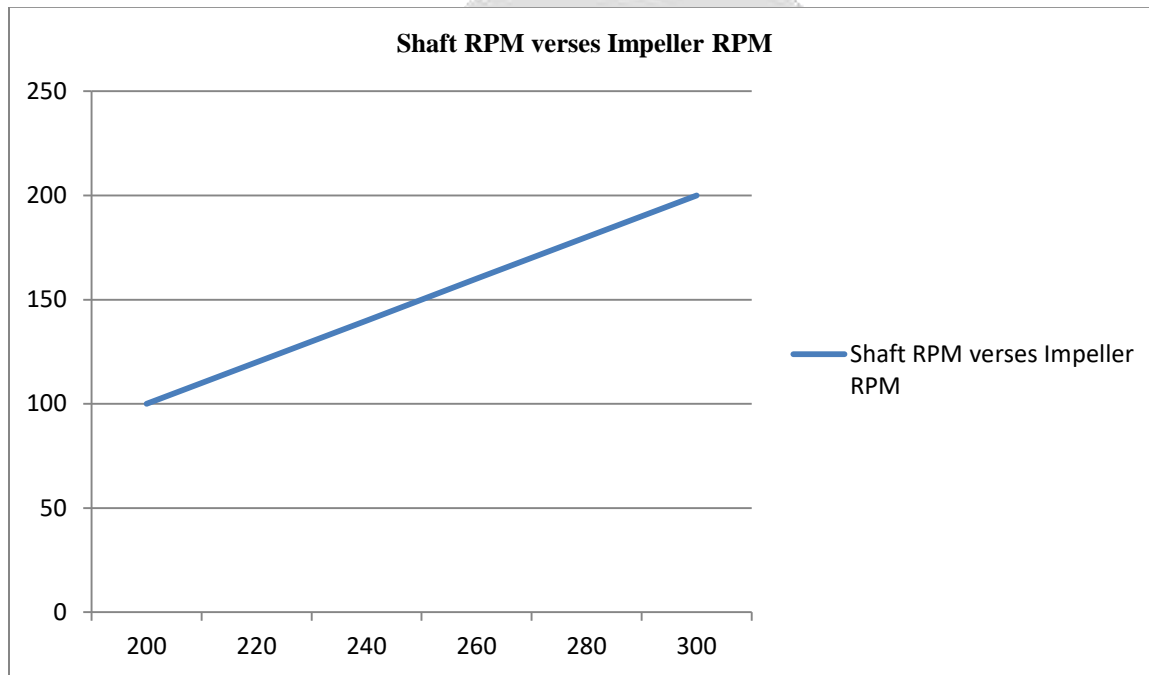
Pedal RPM verses velocity of water:

Sr. No.	Pedal RPM	velocity of water m/s
1	20	10
2	40	20

3	60	30
4	80	40
5	100	50
6	120	60
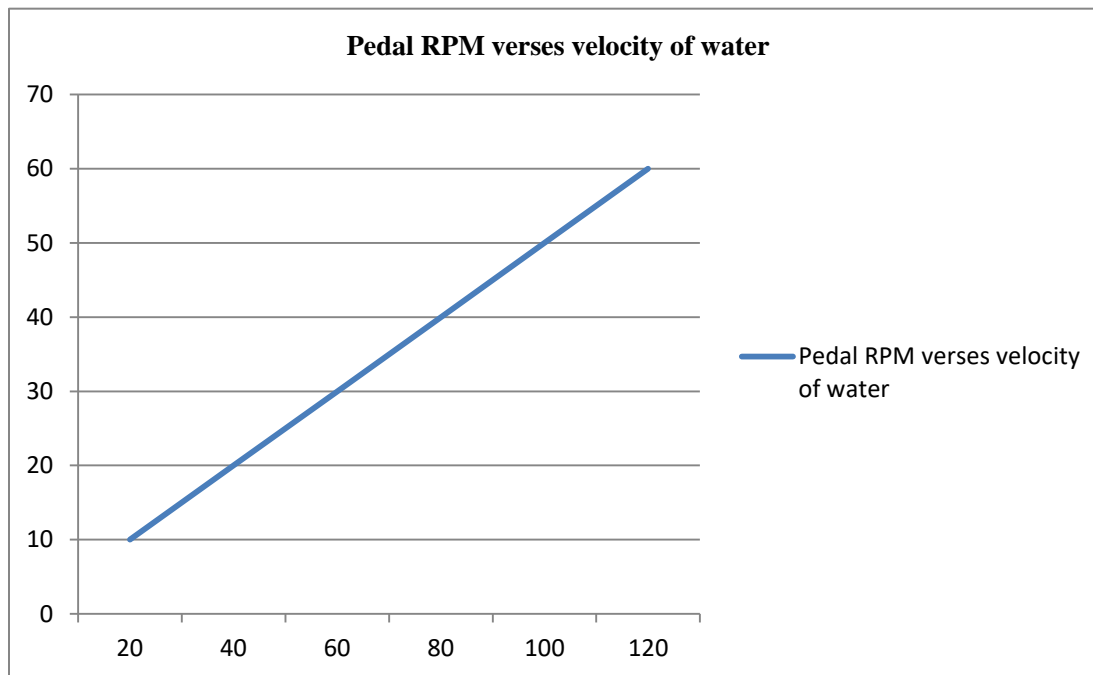
Conclusion:

This project used to lift the water from lower domain towards upper domain i.e. towards overhead tank using advanced minimum RPM impeller via human power assembly. The impeller having capability that the impeller can be able to lift water towards upper higher overhead tank as it is created according to vision i.e. huge suction with minimum RPM so it can be able to absorb water from ground also. This impeller basically hybrid type so it can able to lift water, oil, fuel, highly inflammable solution with any viscosity. This project uses sprocket chain drive mechanism so load transfer is easier with minimum loss is possible. As using human power system main sprocket is rotating and small sprocket is placed over shaft of impeller so power transfer is suitably maximum so with the help of this kind of mechanism i.e. sprocket chain roller system can able to lift water or any solution towards overheat with variable increasing rate dimension that is the advantage of this project that means as system want to lift water greater than previous once so we need to increase the rotation of impeller with few RPM.

Reference:

[1] **H., Krain**, "A Study on Centrifugal Impeller and Diffuser Flow", ASME Journal of Engineering for Power, Vol.103, No.3, 0ctober1981

[2] **Guellich, J. F., Bolleter, U.**, "Pressure Pulsations in Centrifugal Pump", Journal of Vibration and Acustics, Transaction of American Society of Mechanical Engineers, Vol.114, 1992,

[3] **Cornelius Schaffer**, "Pump Condition Monitoring through Vibration Analysis" Pumps: Maintenance, Design, and Reliability Conference, 2008.

[4] **Omprakash, Gupta, K., Nakra, B. C.** ,"Vibration and Noise Monitoring of Centrifugal Pumps", first international symposium on Pump, Noise and Vibrations, Paris, France , July 7-9 , 1993, pp. 493.

[5] **MacKay, E. Szamody, O.**, "Survey of Feed Pump Outages ", EPRI Report no. FP 754, 1978

[6] **Cudina, M. S.** "Noise as an Indicator of Cavitation and Instability in Centrifugal Pumps", Journal of Mechanical Engineering, Vol.45, 1999, pp134–146.

[7] **Khalifa, A. E., Al-Qutub, A. M.**, "The Effect of Impeller-Volute Gap on Pressure Fluctuations Inside a Double-Volute Centrifugal Pump Operating at Reduced Flow Rates", 7th World Conference on Experimental Heat Transfer, Fluid Mechanics and Thermodynamics, Krakow, Poland, 28 June-03 July, 2009, pp. 905-912.

[8] **Bernd Dürrer, Frank-Hendrik Wurm**, "Noise sources in Centrifugal Pumps" Proceedings of the 2nd WSEAS Int. Conference on Applied and Theoretical Mechanics, Venice, Italy, November 20-22, 2006.

[9] **Birajdar, R. Patil, R., Khanzode, K.**, "Vibration and Noise in Centrifugal Pumps- Sources and Diagnosis Methods ", 3rd International Conference on Integrity, Reliability and Failure, Porto/Portugal , 20-24 July 2009.

[10] **Guo, S., Maruta, Y.**, "Experimental Investigation on Pressure Fluctuations and Vibration of the Impeller in a Centrifugal Pump with Vanned Diffusers", JSME International Journal, series B,Vol. 48, No. 1, 2005.

[11] **Torbergsen, E., White, M. F.**, "Numerical and Experimental Study of Impeller/Diffuser Interactions in Centrifugal Pumps", Proceedings of the ISROMAC Conference, Vol.C, Feb.22–26, 1998, pp. 1349–1358.

[12] **Srivastav, O. P., Pandu K. R., Gupta, K.**, Effect of Radial Gap Between Impeller and Diffuser on Vibration and Noise in a Centrifugal Pump, IE(I) Journal- MC, Vol. 84, April 2003.