

# **Design and Fabrication of Pedal Power Top Loaded Washing Machine**

Pal Pandian P<sup>1</sup>, Salinpaul Valooran<sup>2</sup>

Associate Professor, Department of Mechanical Engineering, Christ University Faculty of Engineering, Bangalore,  
India<sup>1</sup>

UG Student, Department of Mechanical Engineering, Christ University Faculty of Engineering, Bangalore, India<sup>2</sup>

**ABSTRACT:** Pedal Powered washing machine (PPWM) is a low cost washing machine made of easily and readily available scrap components (washing machine and bicycle). In our country where approximately 70% population is living with very poor economic status, those people cannot have a washing machine because of cost constraints and unavailability of electricity due to any reason. The present work is an attempt to develop a concept to make a cloth washing mechanism which can meet out the requirements of above mentioned 70% population of the nation. Working principle of this concept is no more different from available similar type of machine with a difference driving mechanism of the machine.

This project is undertaken to solve the problem of villages of India suffering from shortage of electric supply as it requires no power supply. This is a low cost project, portable and can be transported very easily. It is a machine which absorbs the power generated by human pedaling and by the use of drive mechanism converts the pedaling motion into required rotary motion of the drum. Its innovation lies in the use of low cost components i.e. scrap washing machine and bicycle. This is also an eco-friendly project as it is fabricated from recycled components.

**KEYWORDS:** Pedal Power, bevel gears, simple gear train, recycle of materials, transmission shaft

## **I. INTRODUCTION**

Washing machine is a device which imparts mechanical energy to clothes by rotating the agitator water in top loaded washing machine. This project covers one of the daily house-hold activities washing clothes. We all wash clothes either by our hands or use power driven washing machines. This is a very strenuous, time consuming and expensive process. In our developing country, women are among the least privileged. One factor only do women perform agriculture duties and care for livestock alongside men, but women are also responsible for many domestic works. Usually new technology improves people's efficiency but women benefit less from new technology as women are often considered less technically competent than men. Hence the project has the following objectives:

- A machine which does not run on electric power
- Wash any type of clothes
- Must have all the mechanisms- washing, rinsing and drying
- Should be easy to operate
- It should have readily available components and should be ergonomically efficient

## **II. GENERAL DESIGN SPECIFICATIONS**

The most important aspect in the design of the machine is its ability to perform as a device that eases the task of washing clothes. In order to be a viable solution in rural areas, the machine should be able to deliver the same quality of washing without adding excessive overheads (in terms of water use, clothing wear, effort required to operate, etc.). Thus the design and operation of the machine should be firmly grounded in the physics of clothes washing, with a special emphasis on the mechanical aspects (since water temperature and detergent

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

composition are likely to vary). We also identified a number of secondary goals with varying degrees of importance that could help make the machine more useful and thus more successful. The ability to spin-dry clothes would increase water economy by requiring fewer wash cycles, and could relieve the strenuous task of manually wringing the clothes before they are hung to dry. If the layout of the machine allowed the user to perform manual work (handcraft, food preparation, etc.) while pedalling, we could further reduce the amount of time consumed by washing. A number of safety features should also be included in order to mitigate the inherent safety issues involved in a chain-driven machine. If the machine was to be used in a home, insuring its portability would allow it to be shared among families, transported close to a water source for operation, or used in households where space is limited. Another set of specifications for load sizing, water usage and pricing, depend on the targeted community. Since we are expecting the amount of laundry to vary between families, an initial size was selected based on existing washing machines, and designs allowing for easy re-sizing were preferred.

- Cleaning: Machine-washed clothes must be as clean as those hand-washed for 5 minutes
- Gentleness: Must wear clothes at slower rate than hand-washing [hole/tear growth]
- Capacity: Maximum 5 kg
- Water: Effective washing must occur in soft and hard water
- Water usage: Maximum 15L water / 1kg clothes
- Active pedalling time for effective washing: Maximum 20 minutes each for wash and rinse cycles
- Total operation time: Maximum 1 ½ hours, including filling, washing, draining, and cleaning machine
- Lifetime of structure: 5 years, assuming daily use
- Materials: local (scrap washing machine, metals, bicycle parts, etc.)

### III. DEVELOPMENT OF CONCEPT OF MANUALLY DRIVEN PEDAL POWERED WASHING MACHINE

The clothes are washed in pedal powered washing machine like in any other washing machine in 3 basic steps:

- Washing
- Rinsing
- Spin drying

Table 1. Operating Specifications of a Conventional Washing Machine

<i>Process</i>	<i>Time taken (min)</i>	<i>rpm required</i>
Washing	30	20
Rinsing	5	500
Spin drying	15	1000

### IV. A. OPERATING PARAMETERS

It can be seen from Table 1 that the total time required for the entire process is 50 minutes. For, comfortable and efficient power production through pedalling the pedalling rate is taken as 60 rpm. A healthy person produces 125 Watts of power when pedals at 60 rpm under optimal conditions. As, the cycle time is 50 minutes, and maximum sustainable power developed by a healthy man is around 200 Watts. Thus, pedalling at 60 rpm and developing 125 Watts power provides considerable factor of safety for the peddler. Now, keeping the input power constant at 125 W and using different speeds as required for different processes, the torque available at the tub are- for washing the torque available is 59.68Nm, for rinsing the torque available is 2.38Nm and for drying the torque available is 1.19Nm. Minimum torque is the deciding factor for determining the capacity of washing machine as same load of clothes remains during all the three processes.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

## IV.DESIGN AND CALCULATIONS

### IV.A.SIMPLE GEAR TRAIN

The simple gear train is used which is shown in Figure 1, where there is a large distance to be covered between the input shaft and the output shaft. Each gear in a simple gear train is mounted on its own shaft. When examining simple gear trains, it is necessary to decide whether the output gear will turn faster, slower, or the same speed as the input gear. The circumference (distance around the outside edge) of these two gears will determine their relative speeds.



Figure 1. Simple gear train

### IV.B.GEAR WHEEL (SPROCKET) AND CHAIN

Sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it and is shown in Figure 2. A chain is made up of a series of links with the links held together with steel pins. This arrangement makes a chain a strong, long lasting way of transmitting rotary motion from one gear wheel to another.

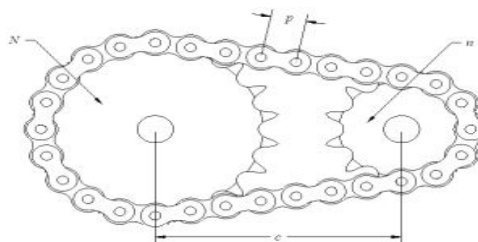


Figure 2 Sprocket and chain

The detailed design calculation for sprocket and chain is given in the Table 2.

Table 2 Design of sprocket and chain

Specifications	Details
Chain Pitch (p)	15.87mm
Number of Countershaft Sprocket Teeth (N)	44
Number of Rear Sprocket Teeth (n)	28
Center to Center of both sprockets (c)	60mm
Number of Links	46
Chain Length	716.31mm
Sprocket Reduction Ratio	0.63
1 rotation of counter shaft sprocket (N)	1.5 rotation of rear sprocket (n)

### IV.C.BEVEL GEAR

Bevel gears are gears where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. Bevel gears are most often mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well. One gear is rigidly mounted on the shaft and another gear is fixed with the bottom of the washing machine. The snapshot of the bevel gear attachment in the modified washing machine is shown in Figure 3.

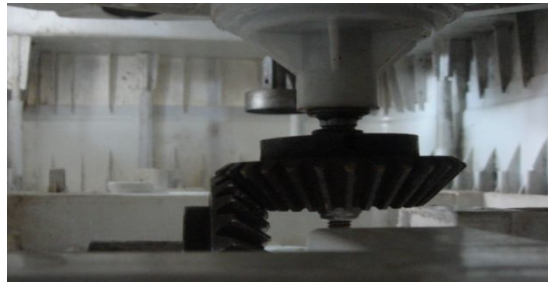


Figure 3. Bevel gear attachment in the modified washing machine

The specifications of bevel gear are shown in Figure 4 and the design calculations of bevel gear is listed in Table 3.

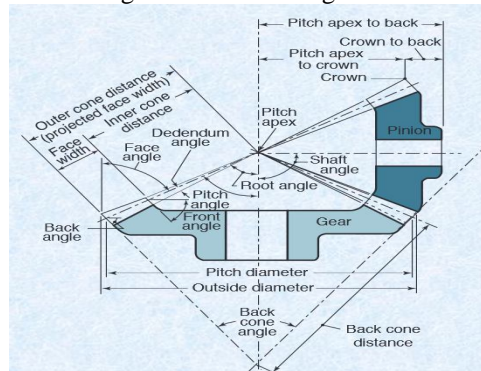


Figure 4. Specifications of bevel gear

Table 4. Design calculations of bevel gear

Specifications	Details
No of teeth on Pinion	30
No of teeth on Gear	30
Diameter pitch $P=N/D$	50
Pitch Diameter $D=N/P$	0.6
Whole Depth $H_t=2.188/P+.002$	0.045
Addendum $a=1/P$	0.020
Dedendum $b=H_t-a$	0.025
Clearance $c=H_t-2*a$	0.0057
Circular Tooth Thickness $T=PI/(2*P)$	0.03142
Pitch Angle $L_p=a*\tan(N_p/N_g)$	45.00010
Pitch Code Radius $R_{cp}=D/(2*\sin(L_p))$	0.42426
Face Width $F=\min(C/3, 8/P)$	0.14142
Outside Diameter $D_{op}=D_p+2*a*\cos(L_p)$	0.62828
Back Cone Radius: $R_{bp}=D_p/\cos(L_p)$	0.42426
Virtual Number of Teeth: $V_p=N/\cos(L_p)$	42.42641

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

### IV.D. BALL BEARING

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



Figure 5. Ball bearing

Ball bearings 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 race. The ball bearings used in our project is shown in Figure 5.

### V. CONSTRUCTION AND WORKING PRINCIPLE

A scrap bicycle is used as frame and power transmission mechanism. The wheels are removed and the cycle is welded to a pre-fabricated assembly as shown in Figure 5. A shaft is welded perpendicular to the rear sprocket of the bicycle. The shaft is supported by ball bearings in order to restrict the bending of shaft during loading. A bevel gear (Pinion) is fixed to the free end of the shaft. A scrap top loaded washing machine is taken. A bevel gear (Gear) is fixed to the main driving shaft of the washing drum. The washing machine is mounted on the pre-fabricated assembly as shown in Figure 6. The assembly is designed so that a proper mesh is maintained between the gear and the pinion as shown in Figure 3.





Figure 6. Assembly of pedal operated top loaded washing machine.

The part drawing and assembly of pedal operated top loaded washing machine is done in Solid edge and the same is shown in Figure 7. As we pedal for one revolution of counter shaft sprocket the rear sprocket rotates 1.5 times. Hence the shaft rotates which in turn rotates the pinion. The pinion rotates 1.5 times and hence the gear fixed to the shaft of the washing machine rotates. Due to which the washing drum rotates agitating the water, detergent and cloth in the drum. Hence washing of clothes takes place. The details of the various washing cycle is given in Table 5.

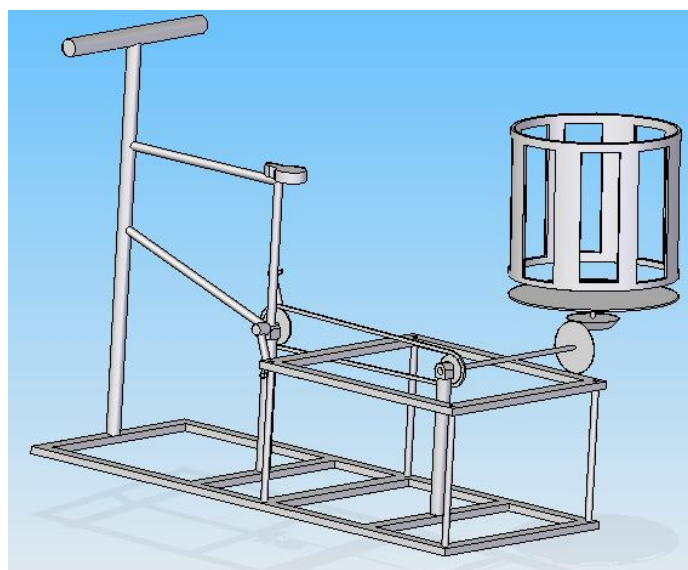


Figure 7. Part and assembly drawing of pedal powered top loaded washing machine

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

Table 5. Details of washing cycle

Washing machine cycle	No of pedaling
Cleaning cycle (50)	42
Rinsing cycle (60)	40
Drying cycle (40)	80

## VI. CONCLUSION

The pedal-powered washing machine is quite different from the community's current method of washing clothes; the community may be reluctant to try the new machine. To help encourage the adoption of the washing machine, this pedal operated washing machine is used in our Christ University Faculty of Engineering Boys Hostel. This pedal power top loaded washing machine has the uniqueness of ease of construction, assembly, transport and made from recycled components. This washing machine can be used in rural areas, where electricity is not available. This economical and efficient washing machine can be used to wash clothes without electric supply and can be used for workout.

## VII. ACKNOWLEDGEMENT

This project work is done as a part of research for Working Paper (Ref: CU:CRP:WPDFE-1407), funded by Center for Research, Christ University, Bangalore.

## REFERENCES

- [1] GaurangBhatawadekar, Budy Salman, NileshChiplunkar, SwapnilDevrukhakar, Singh Akashdeep, "Design and Fabrication of Pedal Powered Washing Machine", International Journal of Engineering Research and General Science Volume 3, Issue 1, pp. 1307-1311, 2015.
- [2] Whitt, Frank Rowland, Wilson, David Gordon, "Bicycling Science", 2nd ed. Cambridge, Massachusetts: The MIT Press, 1983.
- [3] Darrow, Ken, Pam, Rick, "Energy: Pedal Power," from Appropriate Technology Sourcebook, Stanford, California: Volunteers in Asia, Inc. pp.189-196, 1977.
- [4] Bicilavadora: The Pedal-Powered Washing Machine - IDEAS 2005 Proposal.
- [5] <http://home.howstuffworks.com/washer1.htm>
- [6] JayachandraPrabhu, T., "Design of transmission elements", pp. 2.1-2.15, 2008.
- [7] Gitin M Maitra, "Hand book of gear design", second edition, pp. 3.1-3.44, 2002.

## BIOGRAPHY



PalPandian P, Associate Professor of Mechanical Engineering, completed his BE (Mechanical Engineering) from Madurai Kamaraj University, MTech (Industrial Engineering) from National Institute of Technology, Trichy and MBA from Alagappa University. He submitted his PhD (Mechanical Engineering) Thesis to Anna University, Chennai. He has 14 years of experience in Academics. He is an enthusiastic participant at various International and National Conferences/Seminars/Workshops around the World and also presented his research work at the same. He is the recipient of "Teacher Achievement Award 2014". He is a member of editorial board in 3 peer-reviewed International Journals. He has 17 publications in reputed International Journals.



Mr. Salinpaul Valooran is an Under graduate student in the Department of Mechanical Engineering, Christ University Faculty of Engineering, Bangalore.