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Design and Fabrication of Pedal Powered Washing Machine

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Abstract:
Peddling washing machine is a very great innovation in its own. Peddling washing machine is specially made for the purpose of its utilization to wash the cloth by means of applying pedal power. Most of the places in rural areas are still suffering from shortage of electricity because of which they are unable to use most of the electronics appliances for their own betterment. This project includes the construction and utilization of the peddling washing machine which will entirely work on human power generated by the pedaling process under optimum conditions. The following pages in the report includes about the constructions of pedal powered washing machine its principle and surveys for the power generated by human pedaling for the efficient working of the model using easily available resources. It would also help in better health management of an individual as it is totally human powered.

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I. INTRODUCTION:

This project focuses on main household work which is washing clothes, an important work in every individual's house. Most of the people use washing machine for the washing operation of the cloths which is available in most of the houses nowadays. This machine totally works on electricity which is available almost everywhere these days. But most of the rural areas in our country are lacking in the electricity power supply because of which they cannot use most of the appliances working on power supply. Also there are a majority of people in the country who are economically backwards and hence cannot afford washing machine at such high price. We aim to develop a model of washing machine which would entirely work on human power under optimum conditions so as it would work in the rural areas as well as make it affordable by using easily available resources to make it cost efficient and easy for maintenance. Because of the depletion of non-renewable resources at such an alarming rate as they are used for large amount of power generation for industries and well as the increasing population, we need to find an alternative way for the generation of electricity, where we can use the concept of flywheel of the better generation of electricity and also use it in the model of the operation and power storage whenever required. This if possible can also be used on the large scale in urban region for the generation of power and many other health related applications.

Human power survey: human power developed by pedaling operation can be only developed to certain amount. Every individual has its own capacity for any work to do and as it is a continuous pedaling process, it has to be done under optimum conditions and keeping all the human capabilities into consideration. In our survey we discovered that the critical rate for human pedaling can be determined by taking into consideration a group of people coming into certain age limit.

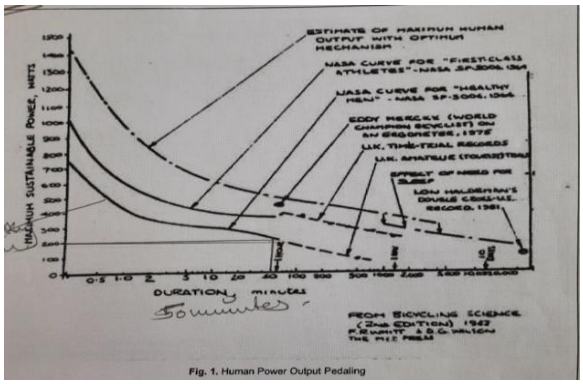


Fig. 1. Human Power Output Pedaling

The following graph shows the power generation among different people considering following conditions. The power levels that a human being can produce through pedaling depend

on how strong the pedaling person is and on how long he or she needs to pedal. If the task to be powered will continue for hours at a time, 75 Watts mechanical power is generally considered the limit for a larger healthy non-athlete. A healthy athletic person of the same build might produce up to twice this amount. A person who is smaller and less well nourished, but not ill, would produce less; the estimate for such a person should probably be 50 watts.

Human beings are very adaptable and can produce power over a wide range of pedaling speeds. However, people can produce more power or the same amount of power for a longer time if they pedal at a certain rate. This rate varies from person to person depending on their physical condition, but for each individual there is a pedaling speed somewhere between straining and flailing that is the most comfortable, and the most efficient in terms of power production. A simple rule is that most people engaged in delivering power continuously for an hour or more will be most efficient when pedaling in the range of 50 to 70 revolutions per minute (rpm). For optimum conditions, we will use 60 rpm, or one revolution of the pedal per second.

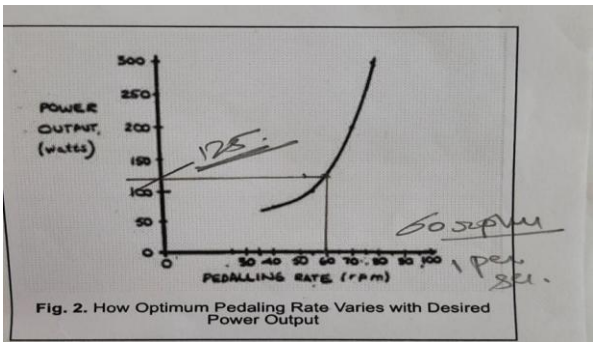


Fig. 2. How Optimum Pedaling Rate Varies with Desired Power Output

Operating Specifications: According to the survey, a human can generate a total amount of 125W of power by pedaling at the rate of 60rpm at a constant rate. At this rate we can distribute the power for the operating specifications of the washing machine. An ordinary electronic washing machine operates at 1400rpm for all the operations. So we can distribute the rpm accordingly. Mainly there are three main -processes to be carried out in the washing machine. They are washing, rinsing and spinning. As in the spinning process, large amount of rpm is required as the cloths are dried in it by the centrifugal action of the drum. So according to the available power and rpm required, we distribute it as follows:

Process	Time Taken	RPM required
Washing	30 minutes	20 rpm
Rinsing	5 minutes	500 rpm
Spinning	15 minutes	1000 rpm

From the above distributed rpm, we can obtain torque for the required processes from basic formulae:

Torque (T) = 9.5488×power (P)/speed (rpm)

Here, we have considered 125W power constant as generated from human. So substituting value of power in above equation, we can obtain required or available torque for different processes. Another alternative of obtaining torque is by power formula.

$$torque(washing) = \frac{9.5488 \times 125}{20} = 59.69Nm$$

$$torque(rinsing) = \frac{9.5488 \times 125}{500} = 2.28Nm$$

$$torque(spinning) = \frac{9.5488 \times 125}{1000} = 1.19Nm$$

Following calculations were done to obtain torque for the operating processes. We have also calculated torque by another method i.e. power formula and same results were obtained. Hence values obtained were considered appropriate.

Process	Time taken	Rpm required	Torque available
Washing	30 min.	20 rpm	59.69 Nm
Rinsing	5 min.	500 rpm	2.38 Nm
Spinning	15 min.	1000 rpm	1.19 Nm

After torque is determined, we can now find the actual power for the following processes. In our survey, we learnt that the minimum torque is the deciding factor for determining the capacity of washing machine as same load od cloths remains during all the three processes. In the above data, minimum torque is 1.19Nm. hence we will obtain actual required power using minimum torque.

$$power(washing) = \frac{2\pi \times 20 \times 1.19}{60} = 2.5W$$

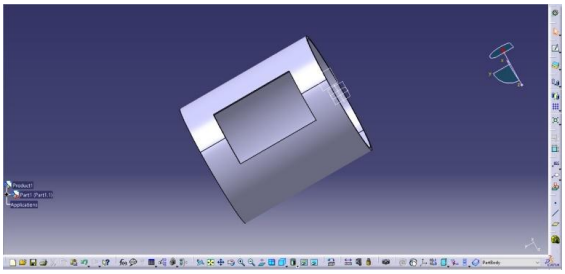
$$power(rinsing) = \frac{2\pi \times 500 \times 1.19}{60} = 62.5W$$

$$power(spining) = \frac{2\pi \times 1000 \times 1.19}{60} = 1000W$$

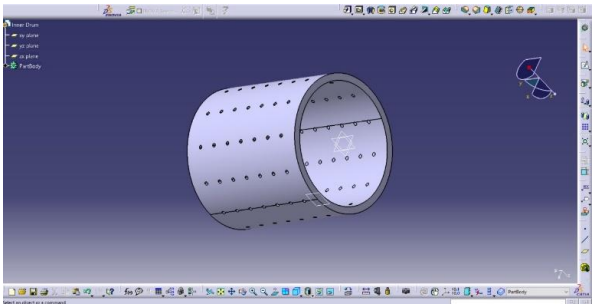
Following calculations were done to obtain actual power required for the operating processes. From

these results, we concluded that the requirement of maximum actual power for the processes get satisfied by the pedaling at the rate of 60 rpm.

3D CAD Modelling: For the proper designing of the cylinder and inner perforated cylinder we made a proper CAD model for both the drums.

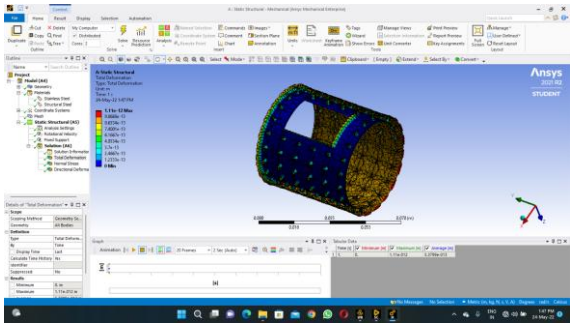


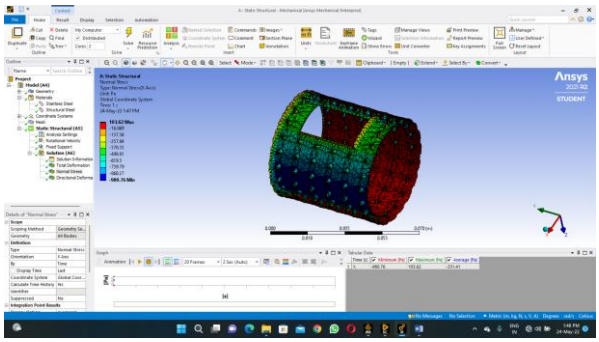
This is the outer cylinder of the washing drum with 45 cm outer diameter and 44.4 cm inner diameter with the thickness of 3 mm, latch of dimension 30×20 cm attached to put the clothes inside the washing drum. Length of drum is 50 cm. Material used for the manufacturing would be galvanized steel to avoid corrosion and defects.

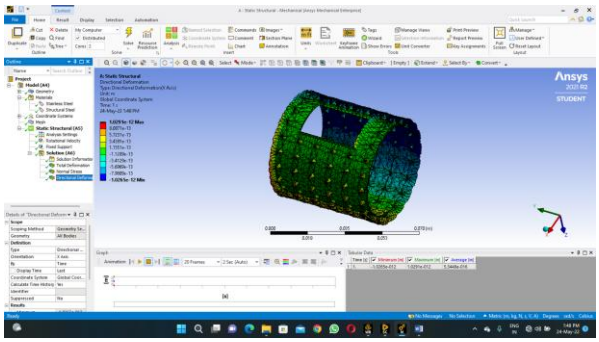


This is the model for perforated cylinder in which actual clots will be getting washed. Dimensions of this cylinder is 44 cm in length and 38.4 cm outer diameter with the thickness of 1.5 mm, inner diameter 38.1 cm. Material used for fabrication is galvanized steel and the perforated holes have the diameter of 7 mm respectively.

Structural analysis: For the better working of the washing machine we have done the analysis considering rpm in rad/sec adding fixed support and rotational velocity. Solving for **total deformation**, **normal stress** and **directional deformation**, we have obtained the following results.







Here we considered 104.71 rad/sec for the rotational velocity analysis by calculating 1000 rpm. In normal stress analysis, most of the pressure is exerted on the inner side of the perforated drum and no load is seen on the outer surface. From the following analysis, we concluded that our model is stable to run with the corresponding calculations and hence there is no breakdown of the model.

Advantages: As this project is totally eco-friendly and human powered, a lot of advantages can be listed down regarding this following such as,

1. Eco-friendly and no more power consumption.
2. Less noisy.
3. Low maintenance cost
4. Cost efficient.
5. Capable of working in any areas, rural and urban.
6. Can also be used for health maintenance as it is totally human powered.

Scope for Future Work: Although the PPWM model work analysis and design is completed, a lot of ideas are left to be undertaken which can be added to the project for its better and efficient working. The concept of flywheel is yet to be added in the project. With the help of this concept we will be generating energy in more amount which will be stored in the battery for later use. We wish to propose the use of pedal power and the power generation can totally replace the electricity power supply where we are on the verge of depletion of renewable resources in the coming next years. So this innovation can be a boon to the later generations well.

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