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# Development of a Human Powered Pedal Washing MACHINE

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**Abstract.** Human powered pedal washing machine has been designed using materials suitable for its application. An existing bicycle was used as the pedal and other parts of the machine such as the drum, the frame was fabricated using galvanized steel. The material selection was put into consideration, such as corrosion because of the machine's involvement with water. The human powered pedal washing machine was tested with a used dirty Laboratory coat. The pedaling washing was first done for the first 15 minutes, using water and sunlight detergent soap. There was a partial cleaning of the Laboratory coat, though the coat was very dirty. Another round of washing was done after which the first washing water was drained out through the outlet part of the machine. The second washing was excellent because the Laboratory coat was clean. The human powered pedal washing machine performed well with all the designed parts functioning well. This is an eco-friendly machine, maintenance cost free, energy conservation machine and highly sustainable for underdeveloped nations of the world.

## 1. Introduction

Cleaning of cloths by washing is a very important activity in human life which requires much energy to do. Washing of clothes with our hands has been in existence, which is as old as man and for centuries ago, before washing machines were invented. Humans make use of streams, nearby rivers or get water from wells to get their clothes washed by hand. The process of hand washing proved to be both consuming time and energy lose, but in order to address those two reasons, the innovation of a machine for washing came up, known as washing machine. Washing machine helps to make life easier and safe human energy. Research by Bhatawadekar et al. [1] revealed that washing machine is purposely constructed for cleaning cloths by using water as fluid and using of energies such as mechanical, chemical and thermal. The first washing machine by Alva Fisher was created in 1901, which uses electricity engine and propelled by the cylinder of a used engine [2]. Washing machines are designed to be electricity powered, whereby the clothes to be washed receives transfer of mechanical energy [3].

Machining is an innovative idea for technology advancement which involves designing of parts and assembling them together to form a whole [4]. The use of materials is not left out during machining of product design because they are the actually the raw ingredients used for making up any product into real life existence. Materials in engineering are of different types (iron, stainless steel, carbon steel etc) and they are chosen for use based on the application of the product to be designed for. They are considered for use due to the properties they possess. For example, good mechanical properties (hardness, strength, ductility, toughness, wear resistance) are contained in ductile iron [5], mild steel, stainless steel etc. There are many factors that are put into consideration during machining and design of products in mechanical engineering. Apart from the materials to be selected, protection of the material



is also important, for instant corrosion is another part that was put into consideration for this research design project.

However, this research work focuses on the development a human powered pedal washing machine that does not require electricity power to work but only requires human activity to keep fit and helps to save electricity energy. This work is based on the principles of pedal motion, where the barrels are rotated causing motion washing in the inner barrel [4-6]. This principle was also used for a shredder equipment that was designed in a bicycle form and powered humanly [7], and for generating electricity produced by Suhalka et al [8].

## 2. Materials and Method

### 2.1. Material used

Material selection on the specific materials to be utilized for any application is often founded on the basis of such a material's properties, suitability of use in the environment of operation, performance, design consideration, cost and compatibility with other materials [9]. Recently, there has been an increase of consideration in the fact that materials are used for designed based on the particular properties utilized for a particular operation, enhanced due to the wide range of materials in existence today.

This aspect of manufacturing products is crucial to obtain an excellent performance from such products, due any design which does not have the proper consideration for its materials based on study and analysis of the specific functionality of each material in the operational procedure of the machine will fail before time. For example, corrosion was put into consideration for this design because of its involvement with water. Water is an excellent agent that aids corrosion, most especially in metals. Corrosion is an unlike natural event that occurs between materials (mild steel, aluminium, stainless steel) and its environment, leading to their gradual destruction [10-14]. This is caused by the flow of current of the metal involved due to the presence of air and any other water agent means.

**Table 1.** Materials used and reasons for selection.

Part	Material selected	Reason
Small aluminum pulley	Aluminum	Aluminum is non-corrosive and resistant to rust, so any splash of water won't affect it
Completely assembled bicycle	-	-
Shaft	Galvanized steel	Resistant to corrosion and durable
Outer cylinder	Galvanized steel	Resistant to corrosion and durable
Inner cylinder	Galvanized steel	Resistant to corrosion and durable
Mesh material	Galvanized Steel	Resistant to corrosion and durable
Bearing (2)	Galvanized steel	Resistant to corrosion and durable
One-way valve	Plastic and Galvanized steel	Resistant to corrosion and durable

### 2.2. Methods

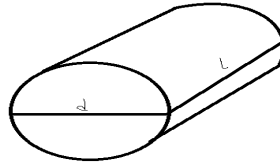
Design considerations for the cylinder

The force carried,  $F_c$  = force of the water carried + force of the clothes carried

= $F(\text{water}) + F(\text{clothes})$

For the design, we are only required to fill one-fifth of the cylinder

Therefore, the volume of water becomes; =  $\frac{\text{volume of cylinder}}{5}$

$$\text{volume of water} = \frac{\pi r^2 h}{5}$$


$$r = \frac{d}{2}$$

$$h = l$$

where  $d = 45.72 \text{ cm}$  or  $0.4572 \text{ m}$

$d = 45.72 \text{ cm} = 0.4572 \text{ m}$  and

$l = 50 \text{ cm} = 0.5 \text{ m}$  (Length of the cylinder).

Therefore;

*mass of water carried = volume \* density (water)*

*weight = 9.81 \* mass*

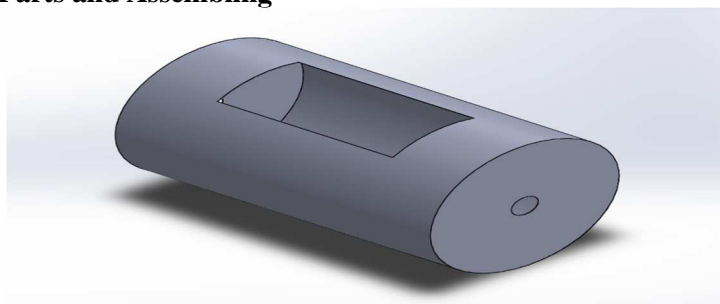
$$\text{weight} = 9.81 * \frac{1}{5} * \pi * \left(\frac{0.4572}{2}\right)^2 * 0.5 * 1000 = 161.05 \text{ N}$$

*Average mass of one shirt = 0.125 kg* [15]

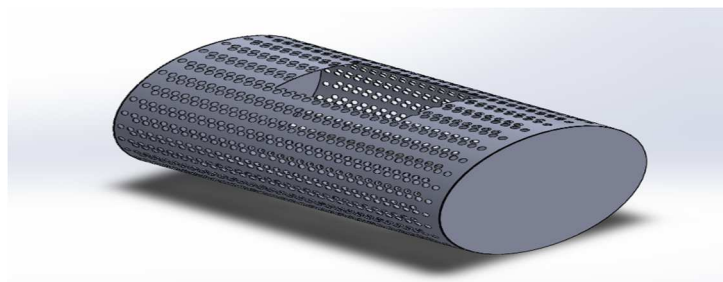
*Assuming 7 shirts, weight = 0.125 \* 9.81 \* 5 = 6.131 N*

thus,  $F_c = 161.05 + 6.131 = 167.18 \text{ N}$

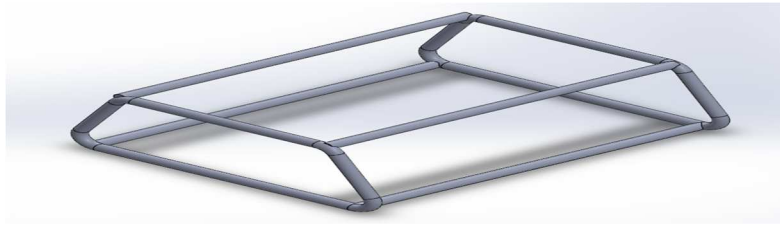
### 3. CAD Modelling Parts and Assembling



**Figure 1.** Cad Modelling for the cylinder shell.



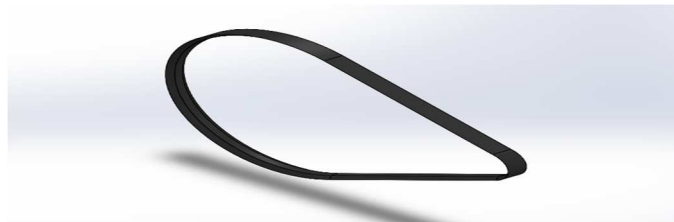
**Figure 2.** Cad Modelling for the perforated cylinder.



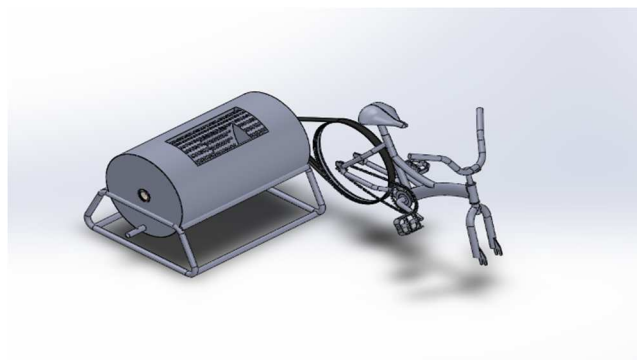
**Figure 3.** Cad Modelling for the cylinder stand.



**Figure 4.** Cad Modelling for the assembling of the cylinder and the stand.



**Figure 5.** Cad Modelling for the belt.



**Figure 6.** Cad Modelling of Assembling.

#### **4. Results and Discussion**

The human pedal washing machine was tested by using a Laboratory coat used from the mechanic workshop, with sunlight detergent soap and water. The pedal was powered and cycled for 15 minutes continuously. The result showed that part of the Laboratory coat was cleaned with the detergent water changing to black colour. The soap water was drained out from the out let tap and replaced with another water and detergent. The washing process was repeated for another 10-15 minutes. There was an improvement in the washing of the coat, which gave a clean wash after another round of cycling, which showed that the washing machine worked successful.



**Figure 7.** Complete Assembly of the Human powered pedal washing machine.

## 5. Conclusion

Human powered pedal washing Machine has been designed with various parts assembled together, using mostly galvanized steel to achieve the machine fabrications. The various CAD modelling of each parts were shown. The human powered pedal washing machine was tested and showed excellent performance in the washing after some minutes of continuous pedaling, which demonstrated the good assembling of the machine mechanisms. The human powered pedal washing machine serve as a washing machine for domestic use, mainly for house use, especially where there is no electricity and also for general exercise of individuals during use. It is easy to use and low cost of maintenance at the long run, energy sustainable (no electricity) and also its eco-friendly.

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