

Design and Analysis of Application of CVT (Continuously Variable transmission) On Activator Washing Machine Mechanic Maximum Capacity 7kg

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ABSTRACT

Washing clothes is an important activity in everyday life, but it requires time, effort and money. Currently there are many washing machines manufactured by products on the market with one-tube and two-tube types that use electrical energy and digital modules as their operating tools. In this study, the application of CVT (Continuously Variable Transmission) in Mechanical Drive Washing Machines is designed, which utilizes human power as a resource so that it can reduce the use of electrical energy and can save costs besides that it can also be a means of exercise. The washing machine tube rotation is generated from the pedal stroke, which is passed from the sprocket or chain ring to the CVT which then goes to the pinion gear as changing the axial CVT rotation position to radial to rotate the washing tube.



KEYWORDS

Washing Tubes
Pedals
Gear Ratio
CVT
Pinion



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1. Introduction

Current technological developments cannot be denied to have a positive impact on everyday life, so that humans can do various kinds of work easily, efficiently and quickly, one of which is the development of technology in the field of washing machines. been done which led to the development of washing machine technology. Such as research that has been conducted by Ajay, Jadoun Hospital, Sushil Kumar Choudhary with the title Design & Fabrication of Manually Driven Pedal Powered Washing Machine, which aims to manually build a low-cost, pedal-powered washing machine that is driven using locally available materials, without using electrical energy [1]. research Relatedcan follow the current development of washing machine technology, but this has not been accompanied by the efficient use of energy resources as the main source of driving the washing machine.

Based on this condition, the authors conducted a research related to the efficient use of electrical resources as the main driving force of a washing machine by using an energy source from the pedaling movement carried out by humans on a pedal that is transmitted via a chain connected to continuous variable transmission, so that the main function of operational movement The washing machine system will still be maintained like movement in general, but the main power source in the form of electrical energy will be removed and replaced by using human power which is transmitted to the CVT (continuously variable transmission).

Research made by Kartika Suhada, Winda Halim and Kelvin with the research title "Design of Energy Efficient, Economical and Environmentally Friendly Washing Machine with Attention to Ergonomic Aspects". Nowadays the process of washing clothes is a common process done in a household. To save energy and washing time, a washing machine is used. The models of washing machines on the market are quite a lot, but in general, existing washing machines have standard functions, use electrical energy, are quite expensive, and use materials that are less environmentally friendly. Based on the various shortcomings that exist, it is necessary to design an innovative washing machine. The method used in this research is a product design concept that starts from seeing the need

to develop the desired product concept to making product prototypes. The washing machine designed in this study can be used to wash all types of clothes weighing 3 kilograms and is equipped with a clothes drying device with a capacity of 20 clothes that participate in the rotation when the washing process takes place, so it will speed up the drying process. In addition, the materials used come from used goods, so the price is economical. This washing machine is designed not to use electrical energy but use kinetic energy, so it is environmentally friendly and can also be used as a sports tool that can nourish the user's body and ergonomics when used.[2]

With this research, it will result in the efficiency of energy resources, especially electrical energy, so that one of the benefits is when this research is made into a washing machine that can actually be used by people who do not have electricity supply in the area, and of course there will be costs that are eliminated for pay for the electrical energy used.

Washing machine is a household appliance which consists of electrical components arranged in such a way that it functions to wash, rinse and dry clothes. Washing machine is basically a machine designed to wash or clean laundry such as socks, clothes and handkerchiefs etc. The washing machine automatically takes the required amount of water and detergent and also automatically sets the timer for washing, rinsing and drying according to the selected mode and the number of clothes.[3] There are two types of washing machines that are commonly used at home, one-tube washing machines and 2-tube washing machines:

- Washing Machine One-Tube

Washing machines In this type of washing machine, there are two different forms according to how you put your clothes in, namely: the top door washing machine. (top loading) and washing machine front loading.[4]



Fig. 1. Types of One-Tube

- Washing Machines Two-Tube

Washing machines The two-tube / washing machines are the twin tube most widely used by our society, perhaps because the price is more economical than the one-tube washing machine. One of the drawbacks is the manual operation method, which is still using the rotary button, starting from turning the knob for washing, drying and disposing of water. So that more attention is needed when we carry out the washing process.[5]



Fig. 2.Washing Machine Two Tubes

- Components of a Washing Machine

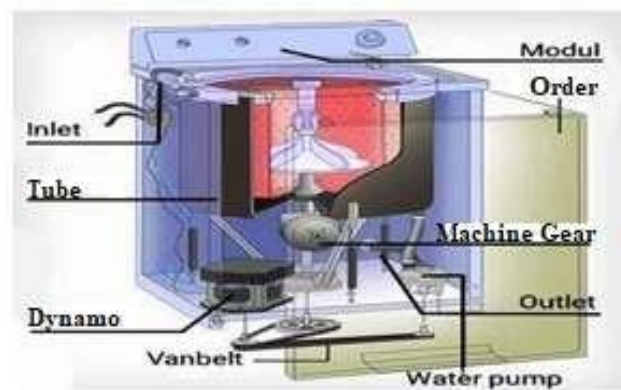


Fig. 3.Washing Machine Components

Table 1. Components Washing Machine

No	Component Name	Function
1	Dinamo	Converts electrical energy into rotating energy
2	Vanbelt	Connects motor to pulley
3	Water pump	Boosts the rate of movement of Water
4	Outlet	The water outlet from the washing tube
5	Machine Gear	Regulator movement of the washing machine
6	tube for	Storage clothes and washing Water
7	Inlet The	place where water enters the washing tube

- Washing Process

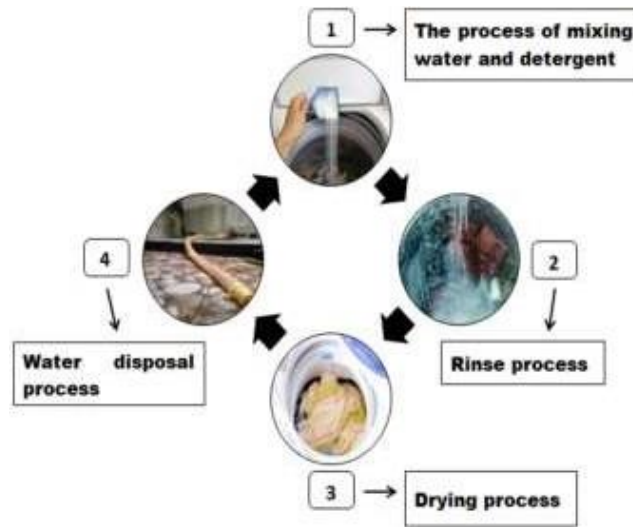


Fig. 4. Washing Process

2. Method

2.1. CVT (Continuously Variable Transmission)

CVT (Continuously Variable Transmission) is a system of transferring power from the engine to the rear tires using a belt that connects the drive pulley to the driven pulley using the principle of friction. Operation is carried out automatically by utilizing centrifugal force. Unlike a manual clutch, the CVT does not use a gearbox that contains a series of gears, so the CVT does not have a gear lock to determine the ratio gear used. The function of the CVT is to make it easier for motorcyclists to regulate speed because the driver does not operate the transmission in the speed setting.[6]

The crankshaft rotation is forwarded to the pulley. With the help of the belt drive the loop from the primary pulley is passed on to the pulley secondary. To rotate the rear wheels on the component, secondary pulley a centrifugal clutch is installed which will rotate the clutch housing to be forwarded to the rear wheels.[7]

The CVT method in this study is a method used to continue the rotation generated by the stroke of human power to rotate a one-tube washing machine according to the Rpm and torque needed for the washing and drying process.

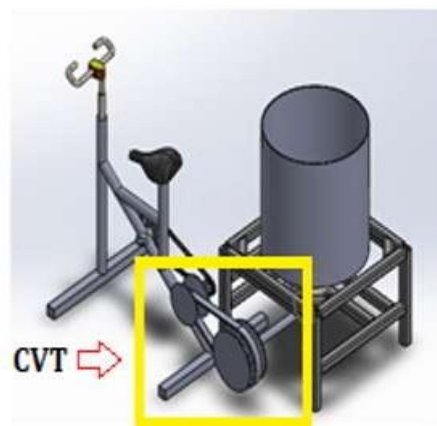


Fig. 5. Construction of the Washing Machine

2.2. CVT Construction

2.2.1. Connection System to Washing Machine

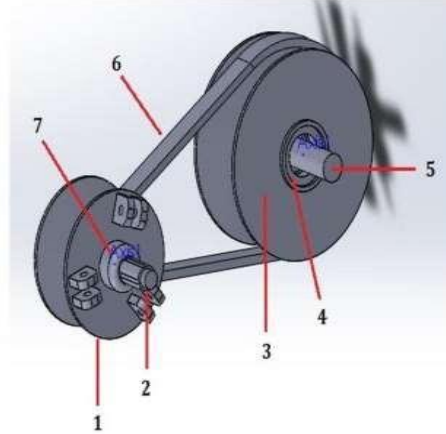


Fig. 6.CVT

Table 2. CVT Construction

No	Name	Function
1	Drive Pulley	As a rotation continuation of pedal stroke
2	Shaft DrivePulley Rotating	axis of the drive pulley
3	Driven Pulley	Forward rotation from the drive pulley to the washing machine speed
4	Spring	Developing the driven pulley
5	shaft Driven PulleyRotary	axis of the driven pulley
6	V-belt The	rotaryfrom the connectiondrive pulley to the driven pulley
7	Bearing	Position of the drive pulley shaft and theshaft driven pulley

2.2.2. System of the CVT to the Washing Machine Tube

Pinion gear drive is a pineapple-shaped gear, which functions as a rotating gear that transmits power from the propeller shaft to a series of axles. Tooth shape like pineapple, this is called hypoid gear. This form is indeed suitable for flowing energy efficiently and gently.[8]

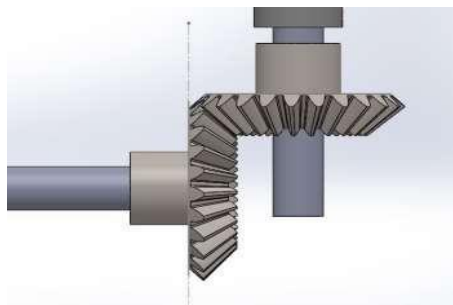


Fig. 7.Drive Pinion Gear

2.2.3. Method of Chain Drive Speed Ratio

$$VR = \frac{n_2}{n_1} = \frac{t_2}{t_1}$$

Information:

N1 = Speed of Small Gear Ratio (Rpm)

N2 = Speed of Big Gear Ratio (Rpm)

T1 = Number of Small Sprocket

T2 = Number of Teeth on Sprocket Large[11]

3. Results and Discussion

3.1. Pedal Design Calculation

CVT will work if the input rotational power or angular speed of the sprocket is at least 750 rpm.[12] Therefore, high gear is used, namely using a small rear sprocket and a large chainring in front. A large gear ratio is used to make the speed more maximal. The rear sprockets used are 11 'T' and Chainring 44 'T'.

- Gear Ratio

$$\text{Gear ratio} = \frac{\text{number of teeth chainring}}{\text{number of teeth sprocket}} = \frac{44}{11} = 4$$

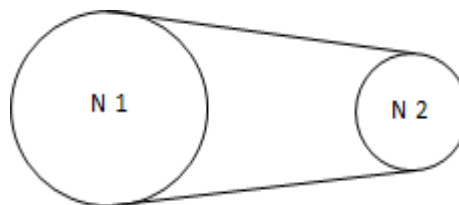


Fig. 8. Gear Ratio

- Front and Rear Pedal RPM Design

The result of the gear ratio is 4, which means that every single rotation of the chainring will rotate the rear sprocket 4 times. For the calculation of the minimum pedal rotation is :

$$VR = \frac{n_2}{n_1} = \frac{t_2}{t_1}$$

$$\begin{aligned} n_1 &= \frac{t_2}{t_1} = n_2 \\ &= \frac{11}{44} \times 750 = 187,5 \text{ rpm} \end{aligned}$$

3.2. CVT Design

Inside the CVT there are two pulleys, namely the drive pulley and the driven pulley which are connected to a v-belt.[13]

- Design of Driven Pulley Angular Speed

The drive pulley is connected to the rear sprocket via the shaft. So that the angular speed is the same, i.e. 750 rpm or 78.5 rad / s drive pulley with a diameter of 12cm.

- Design of Driven Pulley Angular Velocity

The driven pulley has a diameter of 15cm and is in contact with the driven pulley, so that the speed is the same :

$$V_{\text{driven pulley}} = V_{\text{drive pulley}}$$

$$(\omega.R)_{\text{driven pulley}} = (\omega.R)_{\text{drive pulley}}$$

$$\omega_{\text{driven pulley}} = \frac{(\omega.R)_{\text{drive pulley}}}{R_{\text{driven pulley}}}$$

$$= \frac{(78,5)(6)}{7,5}$$

$$= 62,8 \text{ rad/s}$$

$$= 62,8 \times \frac{30}{\pi} = 600 \text{ rpm}$$

3.3. Minimum Power In the Tube

It is assumed that a solid tube with a mass of 18 kg (11 kg tube + 7 kg capacity of washing machine tube) has a diameter of 50 cm and rotates from rest to normal speed for 1 minute (60 s) so that :

$$I = \frac{mr^2}{2} = \frac{18(0,25)^2}{2} = \frac{18(0,0625)}{2} = 0,56 \text{ kg.m}^2$$

$$\alpha = \frac{d\omega}{dt} = \frac{62,8}{60} = 1,05 \text{ rad/s}$$

Then the torque in the tube is:

$$\tau = I \cdot \alpha = 0,56 \times 1,05 = 0,59 \text{ N.m}$$

So that the minimum power required on the tube is:

$$P_o = \frac{\tau \omega}{t} = \frac{(0,59)(2)(3,14)(600)}{30} = 37,05 \text{ W}$$

Table 3. Overall Calculation Results

NO	COMPONENT	RESULT
1	Gear Ratio	4
2	ω Real Sprocket	750 rpm
3	ω Chainring	187,5 rpm
4	ω Drive Pully	750 rpm
5	ω Driven Pully	600 rpm
6	Washing Tube Torque	0,59 N,m
7	A inertia of the whasing tube	0,59 Kg.m ²
8	Washing tubes	1,05 rad/ s ²
9	Washing tube power	37,05 w

4. Conclusion

To transmit the rotation from the bicycle to the wash tube using the transmission shaft, sprocket, chain, CVT and pinion gear drive. From the calculations carried out, it takes a chainring rotating power of 187.5 rpm so that the CVT can operate. The minimum power required to rotate the washing tube is 57,305 W assuming it takes 1 minute from standstill until the tube rotates

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