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TheEffect of Roler Diameter and CVT Spring Variations on Engine Performance

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Abstract—*Vehicles Today's automotive industry and technology is progressing at a rapid pace. The main difference between an automatic motorbike and a manual motorbike lies in the transmission system and the way power is transferred.Many automatic vehicles use an automatic transmission called Continous Variable Transmission (CVT).The function of the roler is to adjust the diameter of the pulley based on the engine speed. Roler is usually cylindrical but this roler has shortcomings. To cover the shortcomings can use a sliding roler.The sliding roler will work best by changing its variation size.The purpose of knowing what is the highest value of power, torque and fuel consumption when using a sliding roler with a weight of 10g, 13g, 16g with Continuously VariableTransmissionspring variations with constants 3.59 N/mm (Standard), 4.15 N/mm, 4.6 N/mm.The test method uses full valve opening to obtain data.Furthermore, the test results data in the form of graphs to be processed using excel were analysed using anova and minitab.Independent variables using sliding roler and CVT spring variations.The fixed variable is Octane 92 fuel.The largest power produced was 7.83 Hp at 6500 rpm using a constant CVT spring of 4.15 N/mm. The maximum torque produced was 8.70 Nm at 6000 rpm using a constant CVT spring of 4.6 N/mm. The highest fuel consumption was 0.1256 kg/hPxhour at 9000 rpm using a 10 gram sliding roler.*

Keywords: *Power, Roler, Torque, Fuel Consumption*

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I. INTRODUCTION

Vehicles Today's automotive industry and technology is progressing at a rapid pace, thanks to the efforts of manufacturers to deliver vehicles in the best possible condition to consumers.Motorcycles, as one of the main automotive products, continue to be developed as they are a very popular means of transport in society, especially in Indonesia. The various technologies that are continuously updated include the fuel supply system, engine construction, frame design, braking system, transmission system and more. [1].

The main difference between an automatic motorbike and a manual motorbike lies in the transmission system and the way power is transferred. In a manual motorbike, the transmission is manually shifted using gear ratios, which allows the motor to reach maximum speed by utilising sprockets and wheel chains to transfer power from the engine to the wheels. In contrast, in an automatic motorbike, there is no need to shift the transmission to achieve maximum speed, as the engine rotation directly drives the primary pulley, secondary pulley, transmission, and wheels. In addition, the transfer of power from the engine to the wheels on an automatic motorbike uses a drive belt and pulleys.[2]

Many automatic vehicles use an automatic transmission called Continous Variable Transmission (CVT) because this system has the advantage of efficient engine work at every vehicle speed compared to manual transmission[3]. The rider does not need to manually change the transmission speed of the vehicle, but automatically changes according to the engine speed, making it very suitable for use in urban areas that are often faced with traffic jams or long tracks outside the city. This automatic transmission motorbike is very comfortable to ride because the transmission shift is soft and there is no pounding like on conventional motorbikes.[4]. In addition to easy maintenance, damage detection is fast and the process of transferring power from the engine to the wheels can be maximised, by changing the size variation of the roler so that it can produce greater pressure on the variator and optimal roler centrifugal force.

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The function of the roler in the automatic transmission regulates the diameter of the pulley when the engine rotates, so it affects the mass of the roler[5].This condition affects the vehicle's ability to accelerate and results in excellent traction performance. At low speeds, high acceleration capability is required.

Vehicle traction performance is the ability of a vehicle to accelerate and overcome obstacles, including rolling resistance, aerodynamics and inclines. In addition to weight, the shape of the roler also affects engine performance because automatic transmissions (CVT) generally use cylindrical rolers. When the upper rotation of the cylindrical roler does not fully rotate so that friction occurs, causing the roler to wear out quickly and the performance of the vehicle at high speeds to drop faster[6].

The use of rolers on automatic motorbikes has a variety of roler types and various weight size variants. So that the replacement of the size of the roler weight variant on automatic motorbikes has 2 choices, namely for the initial rotation or upper rotation on the engine [7].

Research conducted by Fitroh (2019) Research At 7000 rpm, an 8 gram roller produces the highest torque of 10.86 Nm, with an increase of 9.65% or 0.94 Nm, while a standard 11 gram roller produces the highest torque of 8.63 Nm at the same rotation. The highest power at 8000 rpm was obtained with an 8 gram roller.[8].

Research by AL Ilham et al., (2021) the results of this test use a dynotest tool to calculate the power and torque of the vehicle. In the previous data, the engine had 8.3 HP at 5415 Rpm and 14.81 Nm of torque at 3486 Rpm after being modified, the power value rose to 8.4 HP at 4498 Rpm and the torque rose to 15.08 Nm at 3665 Rpm. From this data, it can be concluded that vehicle speed is affected by changes in power and torque[9].

Research conducted by Suhaeri (2018) obtained research results, if the use of Primary Sheave Weight / roller CVT (Continuous Variable Transmission) sliding with weight dimensions of 9.5 grams (lighter than standard) can create optimal peak energy at earlier engine speeds of 7450 rpm, amounting to 4, 45 Hp. The use of Primary Sheave Weight / roller CVT(Continuous Variable Transmission) sliding with a weight dimension of 11.5 grams (heavier than standard) creates optimal energy of 4.54 HP, at engine speeds greater than Primary Sheave Weight / roller with a weight of 9.5 grams, which is 7800 rpm, thus creating a better top speed, this is very suitable for use on a long track[10].

Because every vehicle experiences a decrease in performance, to find out the existing performance, namely with the Dynamometer test tool. Dynotest is a technique used to evaluate the performance of vehicle engines, including cars and motorbikes, by measuring power and torque. Torque describes the engine's ability to move the vehicle from a standstill to a moving position[11].

1.1 Kajian Pustaka

1. How Automatic Transmission Works

The CVT transmission consists of two pulleys connected to each other through a belt, and is equipped with a centrifugal clutch that connects to the rear wheel drive when the throttle is turned. In addition, there is a one-speed transmission gear to reduce rotation. The drive pulley is connected to the crankshaft and functions to regulate speed using centrifugal force. Meanwhile, the driven pulley rotates on the main shaft bearing (input shaft).

2.Slide roler

A sliding roller is a component that is often mounted on a variator, roller housing, or roller pulley. These rollers have a trapezium shape and are available in different sizes and weights for different types of metic motors, affecting the pulling performance as well as the maximum speed of the motor. Unlike the round cylindrical shape of the manufacturing rollers, the sliding rollers are made of self-lubricant Teflon coded SL9, which provides lubrication during friction.

3. CVT Spring

The CVT spring serves as a vital component in a continuously variable transmission system. Its main task is to adjust the distance between the rear pulleys, ensuring that the pulley position matches the desired transmission ratio. In addition, it also plays an important role in compressing the secondary sliding sheave, which helps to keep the CVT belt in the upper position when the engine is idling. With this arrangement, the CVT spring ensures that the belt has optimal contact with the pulley, enabling smooth transitions between transmission ratios and improving the overall efficiency and performance of the transmission system.

4.Torque

Torque is the force released to produce kinematic energy in the form of rotational motion that appears from the time the vehicle is at rest until it runs. The torque formula is as follows:

$$T = \frac{2.\pi.n}{60.Ne}$$

Description:
T : Torque (N.m)
Ne : Power (Hp)
n : Engine speed (rpm)

5.Power

Power is the energy obtained by a machine per unit time during one process. The number of revolutions and the amount of rotation torque are related to the power produced by the engine[12].The amount of power is

$$\mathrm{Ne} = \frac{2\pi \times \mathrm{n} \times T}{60 \times 746}$$

Description:
n : Engine speed (rpm)
Ne : Power (Hp)
T : Torque (N.m)

6.Fuel Consumption

Fuel consumption is the economic value of fuel use. Similarly, fuel consumption shows how much fuel the engine needs at one time[13].The amount of specific fuel consumption is as follows:

$$Sfc = \frac{mf}{Ne}$$

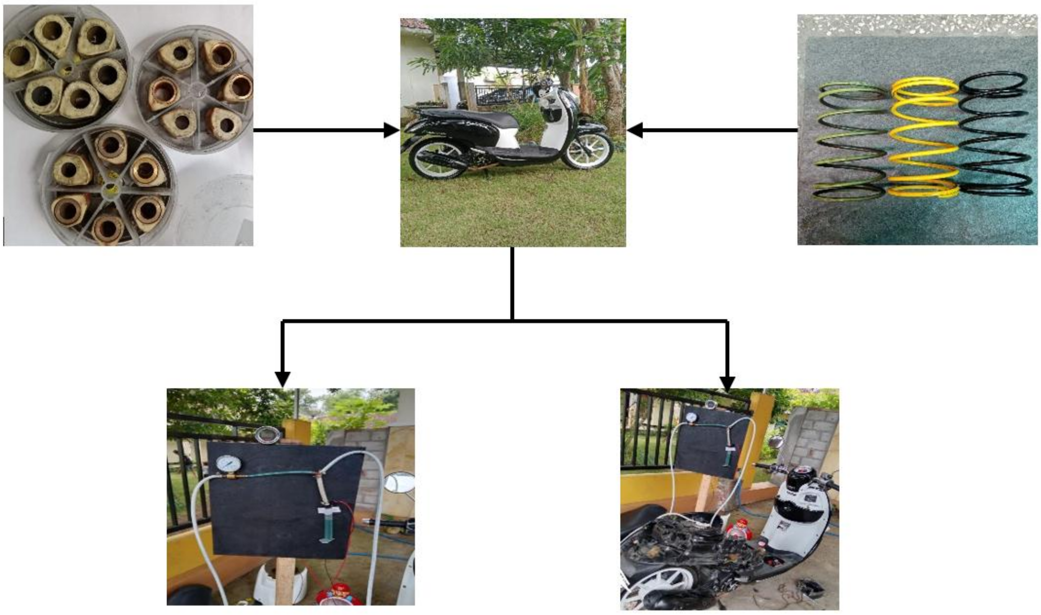
Description:
mf: Fuel flow rate (kg/h)
Ne: Effective shaft power (Hp)
Sfc: Specific fuel consumption (kg/Hp.hour)
The mass formula for fuel flow is

$$mf = \frac{\rho f x v f}{t}$$

Description:
mf : Fuel flow rate (kg/hour)
ρf : Fuel density (kg/m3)
t : Time (seconds)
vf : Fuel volume (m3)

II. METHOD

The test materials consisted of 10g, 13g, 16g shear rollers and CVT springs with a constant of 3.59 N/mm (Standard),4.15 N/mm, 4.6 N/mm then crossed every 1 variation of roler is crossed with 3 variations of spring and then the variation is tested. Tests were carried out using a dynamometer. The parameters measured in this test are engine torque and power at various variations, while fuel consumption is measured with a burette, tachometer, and stopwatch. Measurements were carried out in the engine rotation range of 5000 - 9000 rpm with an interval of 500 rpm.



Gambar 1. Skema Uji

III. RESULTS AND DISCUSSION

1. Power

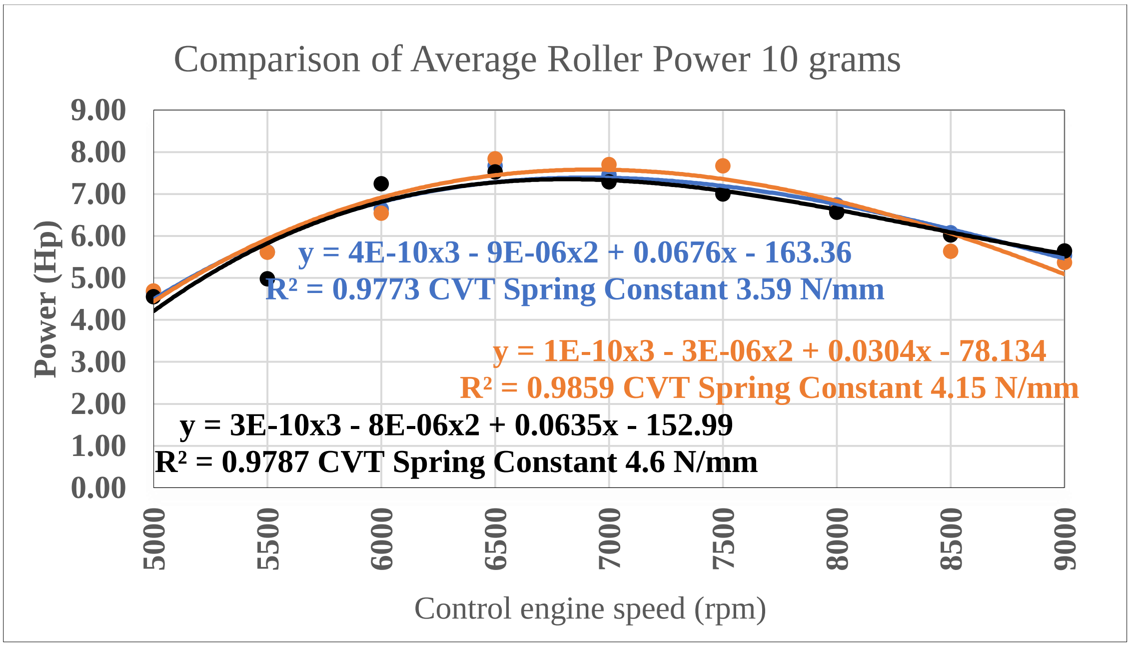


Figure 2. Power when using a 10g sliding roller

The highest power was 7.83 Hp at 6500 rpm using a CVT spring constant of 4.15 N/mm as shown in Figure 2. The use of lighter rollers can significantly improve engine performance. A roller weighing 10 grams, when used at 7000 RPM, is capable of producing 9.75 HP. These rollers are proven to deliver stable and optimal power, making them an effective choice for maximising engine performance[14]

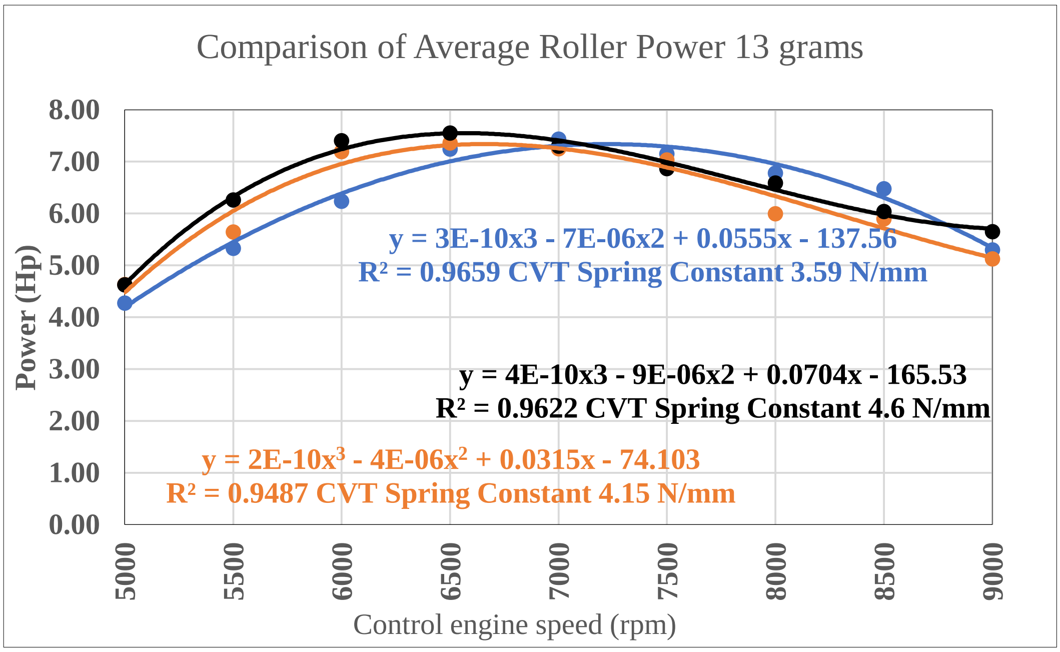


Figure 3. Power when using a 13g sliding roller

Maximum power gets 7.55 Hp at 6500 rpm using a CVT spring of 4.6 N/mm. The maximum power generated is due to the roler used in accordance with the standard size, making it comfortable for long journeys for riders.

This results in reduced frictional contact with the roler housing so as to increase the efficiency of the transmission force.

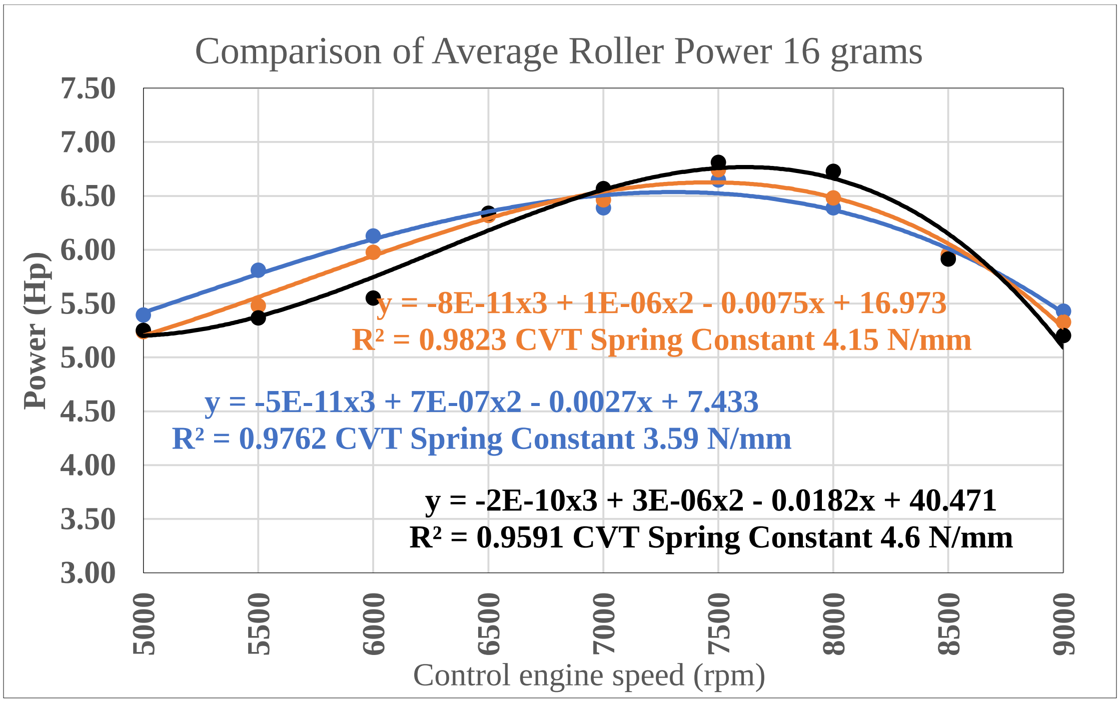


Figure 4. Power When using a 16g sliding roller

Maximum power gets 6.81 Hp at 7500 rpm using a constant CVT spring of 4.6 N/mm. The power generated is less than maximum. This is because the weight of the roler affects the compressive force produced by the roler.

2. Torsi

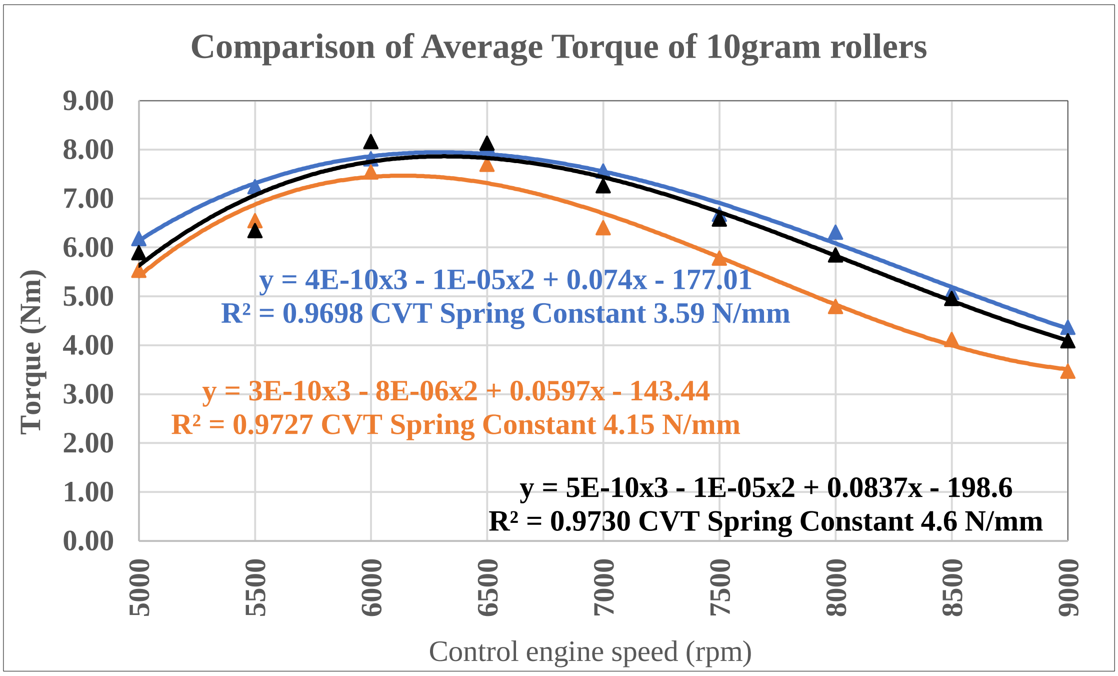


Figure 5. Torque when using a 10g sliding roller

The maximum torque produces 8.16 Nm at 6000 rpm using a CVT spring with a constant 4.6 N/mm. The torque obtained is less than maximum because it is lighter than the standard roler size, thus accelerating the pressure on the variator of the roler housing and facilitating the rapid rise of the v-belt.
According to [15]The weight of the roller has a significant effect on the centrifugal force on the primary pulley, where The heavier the roller, the greater the centrifugal force generated. This force increases the pressure on the V-belt, causing the belt to become tighter as the engine rotates at high speeds. As a result, the transfer of torque and power from the engine to the rear wheels becomes more efficient and robust, allowing for more optimised performance at high revs..

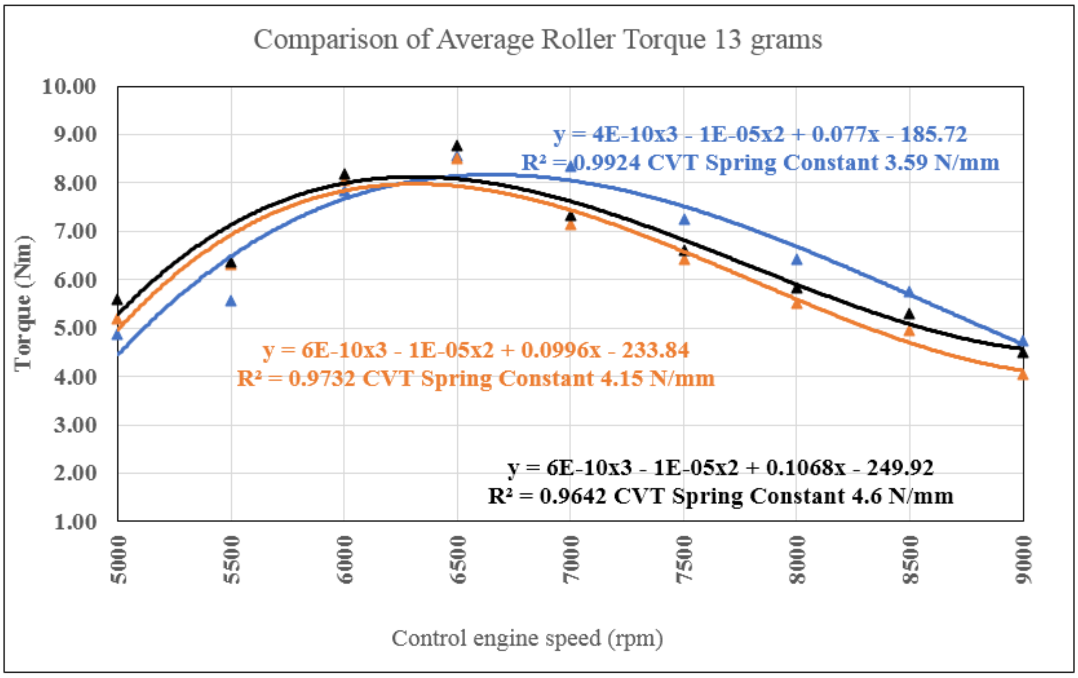


Figure 6. Torque when using a 13g sliding roller

The maximum torque produces 8.70 Nm at 6000 rpm using a CVT spring with a constant 4.6 N/mm. The torque obtained is more maximum because it uses the standard roler weight size, resulting in the variator pressing time on the roler housing not too fast and not too slow so that the power in the engine is channeled optimally. After the torque rises to the maximum there will be a decrease.

According to[16]As the engine rotation speed increases until it reaches peak torque, the torque will automatically decrease even if the engine speed continues to increase.increases. This happens because at higher speeds, the centrifugal force acting on the roller also increases, causing the roller to press the movable drive face to the maximum point. As a result, the diameter of the driven face widens through the V-belt, and the torque passed to the rear wheels decreases due to the pressure of the clutch against the clutch outer.

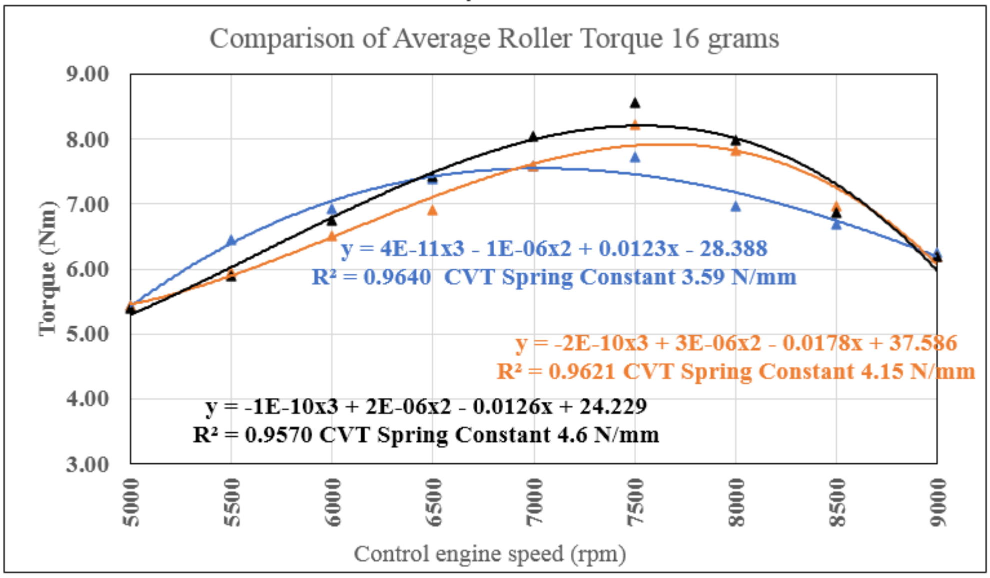


Figure 7. Torque when using a 16g sliding roller

The maximum torque produces 8.55 Nm at 7500 rpm using a CVT spring with a constant 4.6 N/mm. The torque obtained is less than maximum because the roler size is too heavy than the standard. This results in the roler pressing faster so that there is a greater increase in power than torque. According to[17]Power and torque testing using a dynotest showed that racing rollers produced higher average power and torque compared to standard rollers. This difference is due to the difference in engine rotation speed generated by the two types of rollers.

3. Spesific Fuel Consumption

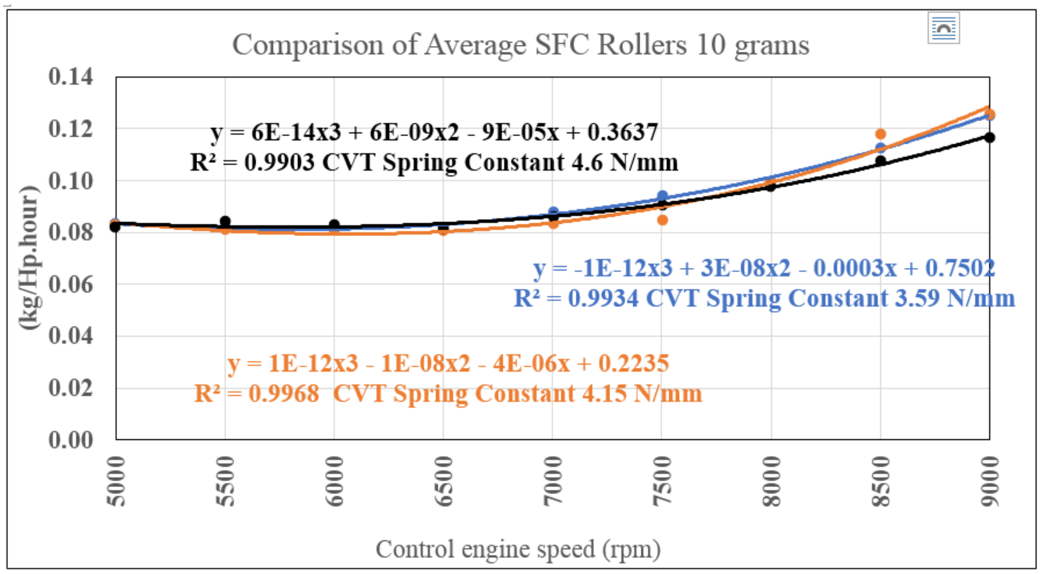


Figure 8. Fuel Consumption When using a 10g sliding roller

The highest fuel consumption with a CVT firmness of 4.15 N/mm gets an SFC of 0.1256 kg/Hp.h at 9000 rpm and the lowest SFC of 0.0807 kg/Hp.h at 6500 rpm. Due to using a substandard size roler, it accelerates the emphasis on the variator on the roler housing and facilitates the rapid rise of the v-belt. Resulting in too early engine performance to be achieved. The lowest fuel consumption, which is 0.0807 kg / hp.hour. This is due to the increase in power which reduces fuel consumption, making the use of fuel more efficient. In accordance with the fuel consumption formula, the higher the power produced, the lower the fuel consumption. According to[18]The use of a 12-gram roller requires additional force to push the roller to compress the V-belt, resulting in increased fuel consumption..

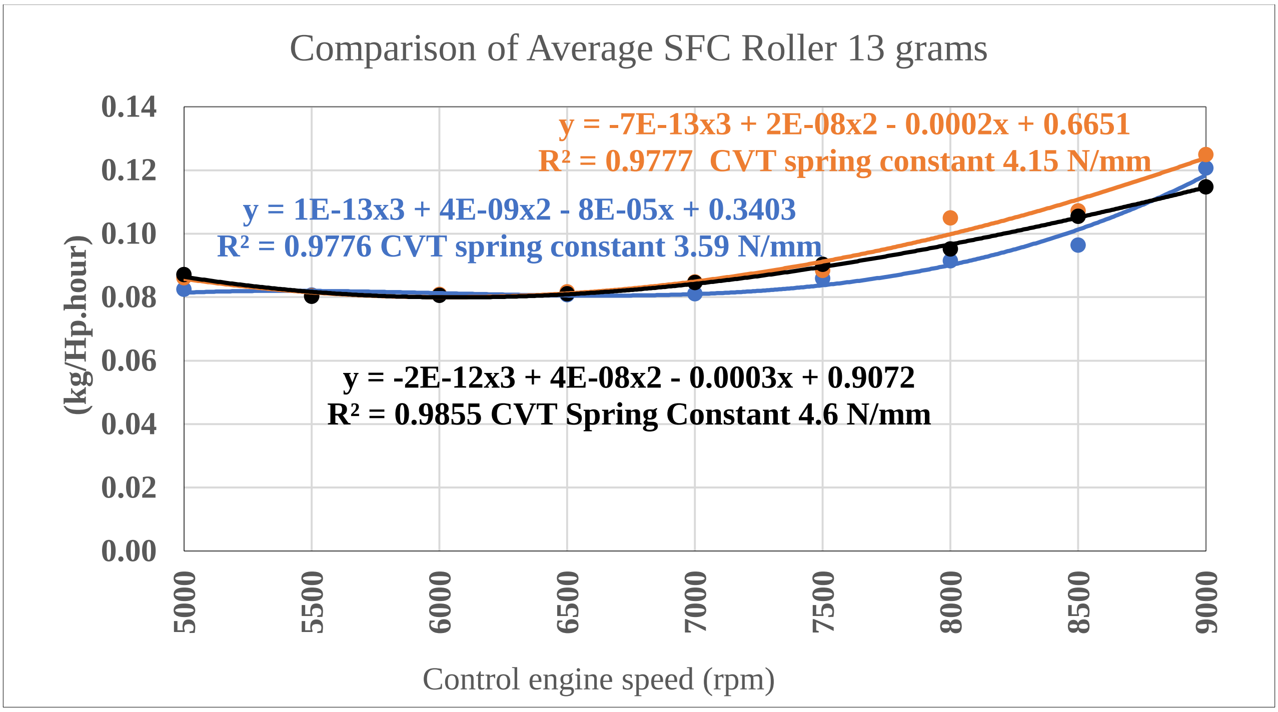


Figure 9. Fuel Consumption When using a 13g sliding roller

The highest fuel consumption with CVT firmness of 4.15 N/mm obtained the highest SFC of 0.1249 kg/Hp.hour at 9000 rpm and the lowest SFC of 0.0804 kg/Hp.hour at 5500 rpm.

The use of a 7-gram roller will lead to an increase in fuel consumption as high engine speeds are required to achieve power in the middle and high ranges. On the other hand, a 16-gram roller will increase fuel consumption even more, as it requireshigher engine speed to push or press the inside of the sliding sheave towards the fixed sheave. This is in line with the moment of inertia theory, which states that the greater the mass of an object, the greater the resistance that inhibits its movement, thus requiring more energy to achieve the desired speed.mesin yang lebih tinggi untuk mendorong atau menekan bagian dalam puli yang bisa bergeser (sliding sheave) ke arah puli tetap (fixed sheave)[19].

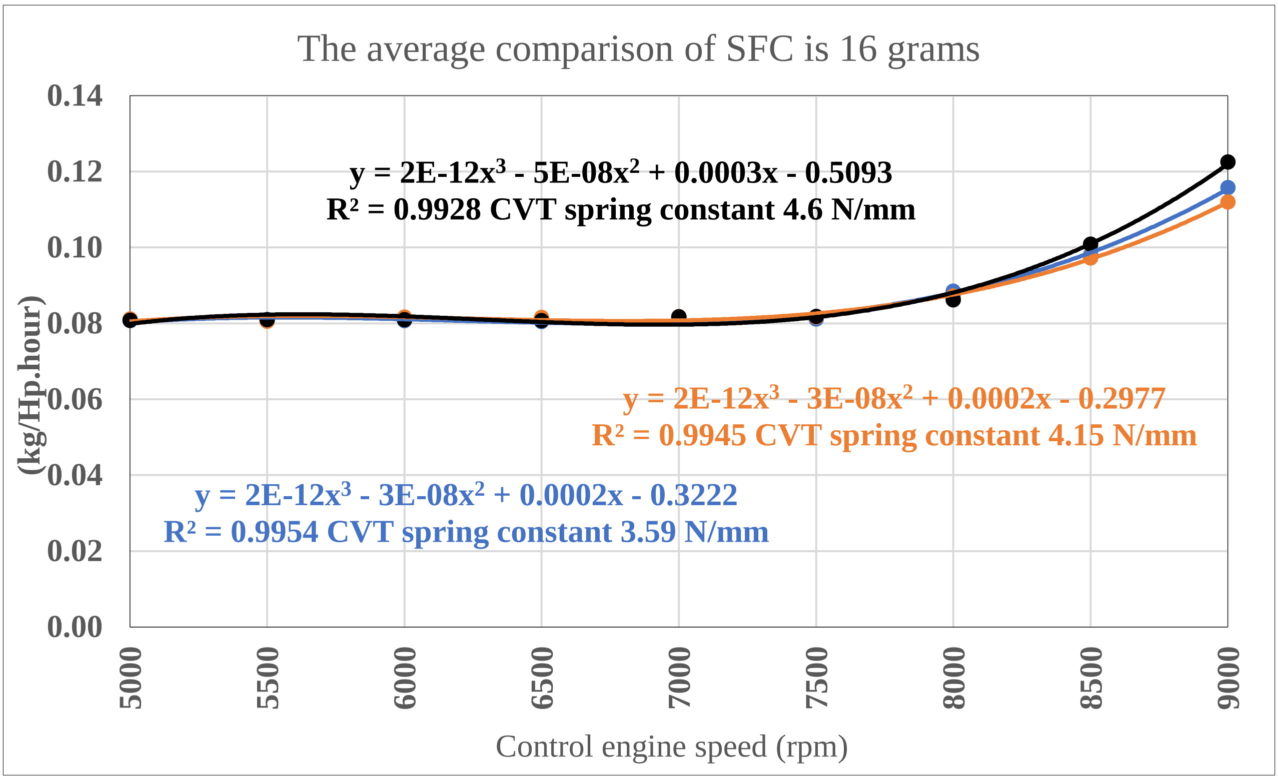


Figure 10. Fuel Consumption When using a 16g sliding roller

CVT firmness of 4.6 N/mm produces the highest SFC of 0.1225 kg/Hp.hour at 9000 rpm and the lowest SFC of 0.0807 kg/Hp.hour at 6500 rpm. This is due to the size of the roler which is too heavy so that the emphasis on the roler housing is faster to produce more economical fuel. In accordance with the above formula the higher the power the lower the fuel consumption. Nik and the decrease in fuel are also regulated by the ECU system.

Menurut [20]With fuel injection controlled by the ECU, the fuel and air mixture can be regulated more accurately, allowing the ECU to calculate the amount of fuel injected and control the flow of fuel and air. Specific Fuel Consumption (SFC) measures the rate of fuel consumption in a piston engine and indicates how effectively the engine utilises fuel to produce power.

IV. CONCLUSION

The greatest power produced was 7.83 Hp at 6500 rpm using a 10g sliding roler and a constant CVT spring of 4.15 N/mm. Getting more maximum power because the roler size is smaller than the standard. This results in slowing down the pressure on the roler housing so as to produce high acceleration. Maximum torque produces 8.70 Nm at 6000 rpm using a CVT spring of 4.6 N/mm. The torque obtained is more maximum because it uses the standard roler weight size, resulting in the variator pressing time on the roler housing not too fast and not too slow so that the power in the engine is channeled optimally. The highest fuel consumption is 0.1256 kg / hp.h at 9000 rpm using a 10 gram sliding roler. Due to using a lighter roler resulting in faster rotation of the crankshaft so that it requires greater engine power. So that the engine performance rotates faster and requires high fuel consumption

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