ANALYSIS OF THE TILT ANGLE OF THE PULLEY DRIVER ON TRACTION AND ACCELERATION PERFORMANCE

[1]Jatira, [2]Dede Ardi Rajab,[3]Choirul Anwar,[4]Rd. Aldi Hardiana Lukman

[1,2,3,4]Mechanical Engineering, STT. Wastukancana Purwakarta ;

[1]jatira@stt-wastukancana.ac.id,[2]dedeardirajab@stt-wastukancana.ac.id,
[3]choirul@stt-wastukancana.ac.id,[4]aldihardiana@stt-wastukancana.ac.id

Abstract

Currently, many people use motorcycles with automatic transmissions. At first automatic transmission motorcycles were only used for women because this type of motorcycle was also very easy to operate and easy to control in all motorcycle variants (Wibowo, Ranto, & MW, 2007). Actually, the difference between automatic motorcycles and other types is only in the transmission system. The transmission system on automatic motorcycles is part of a difference called CVT (Continuously Variable Transmission). In the CVT (Continuously Variable Transmission) system, the engine performance is getting heavier. And the efficacy of the engine is on the engine power which is not much compared to the class of all motorcycles (Sandy Adam Mahaputra, 2011). The definition in this study is to overcome the weakness of engine performance in the CVT system that many customers complain about. This research study is focused on comparing vehicle acceleration with engine traction power between modified driver pulleys and standard driver pulleys using a dyno performance test tool (dynamometer).

Keywords : *CVT, Pulley, motor cycle, Dynamometer.*

1. INTRODUCTION

The type of motorcycle that is most widely used in modern times is the automatic type of motorcycle. Initially, automatic motorcycles were specifically for women. This is because automatic motorbikes are small in size and easy to operate, so they are expected to be easy to use by women(Wibowo, Ranto, & MW, 2007).

The thing that distinguishes automatic motorcycles from other types of motorcycles lies in the transmission system. Automatic motorcycles use an automatic transmission system commonly known as CVT (Continuously Variable Transmission). The basic difference between CVT and other power transfers is the way it transmits torque or power from the engine to the wheels. In CVT, gears are no longer used to lower or increase the rotation of the wheels, instead two pulleys and a belt are used.(Greetings, 2016).

Continuously Variable Transmission (CVT) consists of a primary pulley (primary pulley or driver pulley) and a secondary pulley (secondary pulley or driven pulley) connected by a v-belt. (ILMY, 2018). In the CVT (Continuously Variable Transmission) system, the most striking thing to complain about is the engine performance. The performance provided by this automatic motorcycle is considered less powerful (Sandy Adam Mahaputra, 2011).

The function of the pulley in the CVT system is very important, namely as a power transmission from the crankshaft to the rear wheels which are connected by a v-belt. The pulley that plays an important role in the CVT system is the pulley driver where the diameter can change automatically which is influenced by engine speed based on the centrifugal force that occurs due to the push from the roller.

To overcome complaints of engine performance problems, many automatic motorcycle users make modifications to CVT components by replacing after-market spare parts. One of them is changing the tilt angle of the standard driver pulley with a modified driver pulley which is expected by changing these components to improve vehicle performance.

2. LITERATURE REVIEW

2.1 Continuously Variable Transmission (CVT) System

Continuously Variable Transmission(CVT) is an automatic transmission that works based on the centrifugal force and frictional force that occurs in the CVT components. The speed shift is fully automatic according to the engine speed. This CVT system no longer uses a transmission, but instead uses two pulleys connected to a v-belt. With this system the driver no longer needs to operate gearshift. Just by turning the gas handle to increase and decrease the speed of the motorcycle.

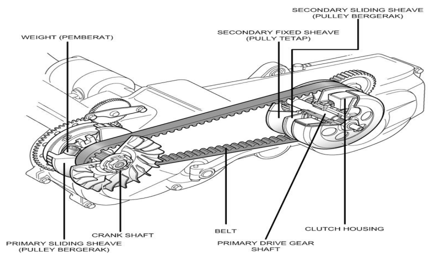

Figure 1. Continuously Variable Transmission (CVT) System

2.2 Traction (Thrust) Vehicle

(Tenaya & Atmika, 2004)Traction characteristics on motorized vehicles basically include the ability of the vehicle to accelerate, and overcome obstacles that occur. Among them rolling resistance (rolling resistance), incline resistance, as well as aerodynamic drag. (ILMY, 2018)To move the vehicle requires sufficient thrust to fight all the obstacles that occur in the vehicle. The thrust of a vehicle occurs on the drive wheels of the vehicle. This thrust is transformed from the torque of the vehicle engine which consists of the clutch, transmission, differential gear, and drive shaft. The thrust force on the drive wheels of the vehicle which is transmitted from the vehicle engine is formulated as follows:

$$Ft = \frac{Te.\ it.\ ig.\ \eta t}{r}$$ ……………………………..(1.10)

Where :

Ft : Vehicle Thrust (N)

Te : Engine Torque (Nm)

it : Transmission Comparison

ig : Final Gear Comparison (Gardan)

ηt: Transmission Efficiency

ηt : 0.88 – 0.92

(Machine Located Longitude)

ηt : 0.918 – 0.95

(Machine Located Transversely)

r : Radius of Drive Wheel (m)

2.3 Air Resistance (Aerodynamic Resistance)

(Tenaya & Atmika, 2004) If there is an object moving in a fluid medium or vice versa, the fluid moving past an object will experience the forces acting on it. Likewise, vehicles moving in atmospheric air are also affected by the interaction of motorcycles with the road, will experience aerodynamic forces whose magnitude depends on the relative speed between the air and the object itself.

The components of aerodynamic forces are aerodynamic drag (Fd), aerodynamic lift (Fl), and aerodynamic side forces (Fs), where the formula is:

$Ra = \frac{1}{2} . \rho . Af . Cd . V^2$ ………………………(3.1)

Where :

Ra : Aerodynamic Resistance (N)

ρ : Air Density (Kg/m^3)

A_f : Vehicle Frontal Area (m^2)

V : Relative Speed between vehicle and air (m/s)

C_d : Coefficient – Aerodynamic Coefficient

Table 1. Aerodynamic drag coefficient

Jenis Kendaaraan	Koefisien Hambat
Kendaraan penumpang	0,3 - 0,6
Kendaraan convertible	0,4 - 0,65
Kendaraan balap	0,25 - 0,3
Bus	0,6 - 0,7
Truck	0,8 - 1,0
Tractor - trailer	0,8 - 1,3
Sepeda motor + pengendara	1,8

2.4 Vehicle Acceleration

Acceleration or acceleration is the change in velocity in a certain unit of time. In the laws of physics given the symbol "a". in fact, the speed of moving objects is not always constant, aka always changing. This change in velocity is called acceleration.(Ilmy & Sutantra, 2018) The easier the vehicle is to accelerate at each speed, the better the thrust of the vehicle. Vehicles that are easily accelerated will be very easy to overtake other vehicles. The magnitude of the acceleration of the vehicle on a flat road is formulated as follows:

$a = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1}$ ....(8.1)

where :

a : Average acceleration (m/s^2)

Δv : Change of speed (m/s)

Δt : Time lapse(s)

V : Initial speed (m/s)

V : Final speed (m/s)

T : Initial time(s)

T : End time(s)

3. RESEARCH METHODS

In this study the method used is an experimental research method with a quantitative approach. According to Hadi (1985), experimental research is research conducted to determine the consequences of a treatment given intentionally by the researcher. Meanwhile, according to Sugiyono, experimental research is a research method used to find the effect of certain treatments on others in controlled conditions. Based on the definitions from these experts, it can be concluded that experimental research is research conducted to determine the effect of giving a treatment or treatment to research subjects. Research variables are everything that will be the object of research observation.

The independent variable is the variable that affects or is the cause of the change or emergence of the dependent variable. In this study there are 2 independent variables, including the following:

1. Driver Pulley Tilt Angle.
2. Variation of V-Belt Type.

The dependent variable is the variable that is affected or becomes the result of the independent variable. In this study the dependent variable is as follows:

1. Vehicle Traction Performance.
2. Vehicle Acceleration.

4. RESULTS AND DISCUSSION

The results of this research and discussion are obtained from theoretical studies and vehicle performance testing using a dynamometer or often called a dyno test.

From the results of vehicle performance testing, data analysis is then carried out to obtain a comparison of the value of traction and vehicle acceleration between *pulley drivers* modified and varied standards with two different types of v-belts as shown by the comparison chart.

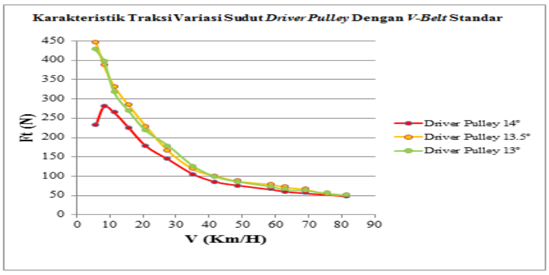

Figure 2. Graph of Variation Traction Characteristics *Driver Pulley* With Standard V-Belt

Figure 2 describes a comparison of the traction performance of three variations of the driver pulley angle using a standard v-belt. From the results of the analysis and calculations, that the pulley14° driver produces the largest traction of 279,570 N at a speed of8.21 Km/H. 13.5° driver pulley delivers the greatest traction of 446.92 N at speed4.55 Km/H. Driver Pulley 13° delivers greatest traction 426,173 N at speed4.46 Km/H.

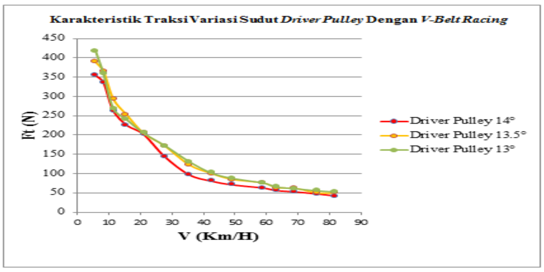

Figure 3. Graph of Variation Traction Characteristics *Driver Pulley* With V-Belt Racing

Figure 3 describes the comparison of the traction performance of the three variations of the driver pulley angle using v-belt racing. From the results of the analysis and calculations, that the 14° pulley driver produces the greatest traction of 354.163 N at a speed of4.90 Km/H. The 13.5° driver pulley provides the greatest traction of 388,721 N at speed4.88 Km/H. Driver Pulley 13° delivers maximum traction of 417,706 N at speed4.65 Km/H.

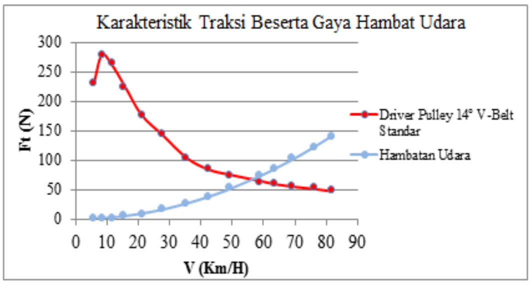

Figure 4. Graph of Driver Traction Characteristics *Pulley* 14° With Standard V-Belt And the Influence of Barrier Force Air

Figure 4 explains the relationship between traction and air drag, which is to determine the maximum speed of the vehicle by finding the intersection of the traction and air resistance values on the graph. 14° pulley driver with standard v-belt provides maximum speed with air drag of58.87 Km/H.

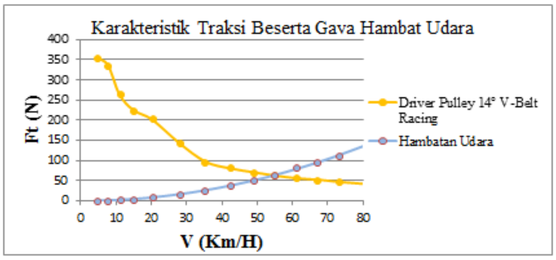

Figure 5. Driver Traction Characteristic Graph *Pulley* 14° With V-Belt Racin and The Influence of Barrier Force Air

Figure 5 explains the relationship between traction and air drag, which is to determine the maximum speed of the vehicle by finding the intersection of the traction and air resistance values on the graph. The 14° driver pulley with v-belt racing delivers maximum speed with an air drag of55.02 Km/H.

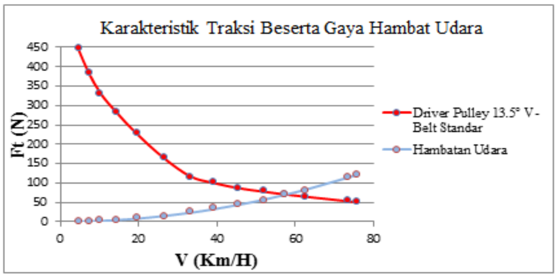

Figure 6. Graph of Driver Traction Characteristics *Pulley* 13.5° With Standard V-Belt And the Influence of Barrier Force Air

Figure 6 explains the relationship between traction and air drag, namely to determine the maximum speed of the vehicle by finding the intersection of the traction and air resistance values on the graph. 13.5° driver pulley with standard v-belt delivers maximum speed with air drag of56.94 Km/H.

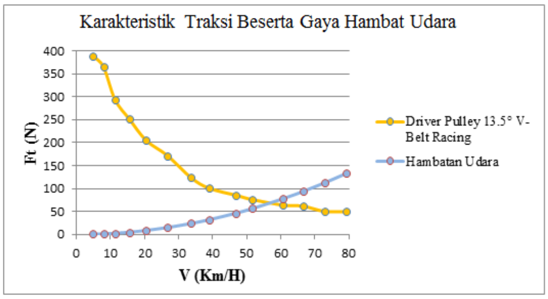

Figure 7. Graph of Driver Traction Characteristics *pulley* 13.5° With V-Belt Racing And the Influence of Barrier Force Air

Figure 7 explains the relationship between traction and air drag, which is to determine the maximum speed of the vehicle by finding the intersection of the traction and air resistance values on the graph. Driver pulley 13.5° with v-belt racing delivers maximum speed with air drag of60.74 Km/H.

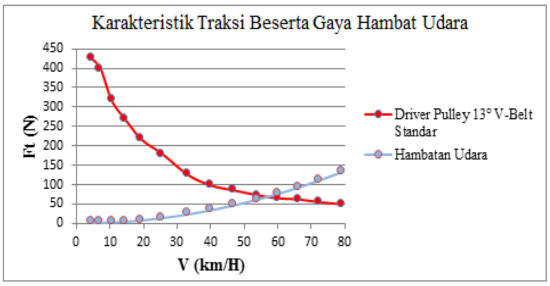

Figure 8. Graph of Driver Traction Characteristics *Pulley* 13° With Standard V-Belt And the Influence of Barrier Force Air

Figure 8 explains the relationship between traction and air drag, which is to determine the maximum speed of the vehicle by finding the intersection of the traction and air resistance values on the graph. 13° driver pulley with standard v-belt delivers maximum speed with air drag of54.01 Km/H.

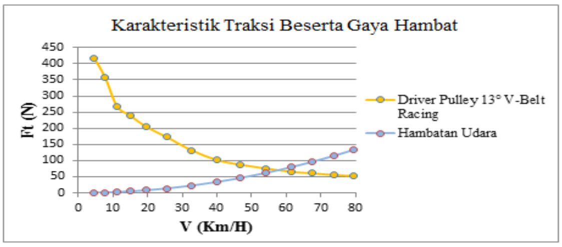

Figure 9. Driver Traction Characteristic Graph *Pulley* 13° With V-Belt Racing And the Influence of Barrier Force Air

Figure 9 explains the relationship between traction and air drag, which is to determine the maximum speed of the vehicle by finding the intersection of the traction and air resistance values on the graph. 13° driver pulley with v-belt racing delivers maximum speed with air drag of54.01 Km/H.

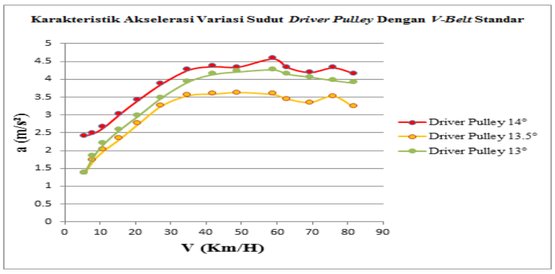

Figure 10. Graph of Acceleration Characteristics Variation *Driver Pulley* With V-Belt Standard

Figure 10 describes a comparison of the acceleration of the three variations of the driver pulley angle using a standard v-belt. From the analysis and calculation results, that the 14° pulley driver produces the greatest acceleration of 4.56 m/s² at a speed of58.87 Km/H. Driver pulley 13.5° provides the greatest acceleration of 3.62 m/s² at speed45.73 Km/H. Driver Pulley 13° provides the greatest acceleration of 4.26 m/s² at speed54.01 Km/H.

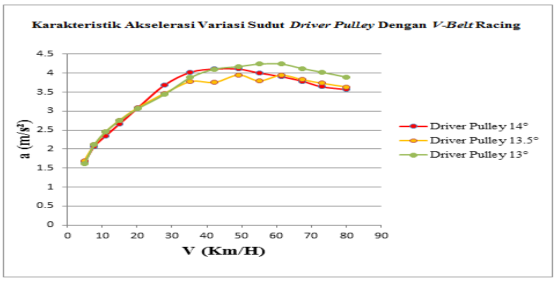

Figure 11. Graph of Acceleration Characteristics Variation *Driver Pulley* With V-Belt Racing

Figure 11 describes the comparison of the acceleration of the three variations of the driver pulley angle using v-belt racing. From the results of the analysis and calculations, that the 14° pulley driver produces the greatest acceleration of 4.10 m/s² at a speed of42.29 Km/H. The 13.5° driver pulley produces the greatest acceleration of 3.95 m/s² at 46.92 Km/H. Driver Pulley 13° delivers the greatest acceleration of 4.23 m/s² at 54.01Km/H.

CONCLUSION

From the results of the analysis and testing that has been done, it can be concluded in this study, namely as follows:

1. Changes in the tilt angle of the pulley driver greatly affect the traction and acceleration performance of the vehicle. Where the modified components provide better traction performance than the standard components and while for the acceleration performance the standard components are better than the modified components.
2. *Driver pulley* with a tilt angle of 13.5° using a standard v-belt is able to produce the greatest traction (thrust force) value of 446,928 N at a speed of 4.55 km/h.
3. *Driver pulley* with a tilt angle of 13.5° using a v-belt racing capable of producing a maximum speed with the influence of air drag, which is 60.74 km/h.
4. *Driver pulley* with a tilt angle of 14° using a standard v-belt produces the largest acceleration value at medium speed, namely 4.56 m/s² at a speed of 58.87 km/h.
5. From all the variations in the tilt angle of the driver pulley combined with 2 different types of v-belts, it can be concluded that the 13.5° driver pulley with a standard v-belt is more suitable for acceleration at low speeds because it produces greater traction. As for the 14° pulley driver with a standard v-belt, it is more suitable for acceleration at high speeds because it produces less traction.

The suggestions from this research that are given by the author to the readers so that this research will be better in the future are as follows:

1. Further research is needed to determine the effect of changes in the inclination angle of the pulley driver on the slip value and age of the v-belt.
2. It is necessary to test directly on the street to compare the data from the performance test (dyno test) and analysis with the data from the test results directly on the street.
3. It is highly recommended that the vehicle must be in optimal condition.

REFERENCES

Ilmy and IN Sutantra, "The Effect of Variation of Spring Constants and CVT Roller Mass on the Performance of Honda Vario 150 cc," J. Tek. ITS Vol. 7, No. 1 (2018), 2337-3539 (2301-9271 Print) Influence, vol. 7, no. 1, 2018.

RP Ramadhan and IN Sutantra, "Experimental Study of the Effect of Clutch Spring Variations on Thrust and Acceleration Forces on Yamaha Vixion 150 cc Vehicles," J. Tek. ITS Vol. 5, No. 2, ISSN 2337-3539 (2301-9271 Print), vol. 5, no. 2, 2016.

GNP Tenaya and IKA Atmika, “Traction Characteristics And Transmission Performance In Gear Transmission And Gearless Transmission Systems,” Vol. 3, No. 2, Pp. 20–25, 2004.

I Nyoman Sutranta. Bambang Sampurno, Automotive Technology, 2nd ed. Surabaya: Guna Widya, 2001.

RA Wibawa, "Influence Of Primary Pulley Angle Changes On Power And Torque On 4 Step Automatic Transmission Motorcycles," 2014.

N. Satria, “Damage Analysis Of Continuosly Variable Transmission Honda Beat Year 2011,” 2017.