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Experimental Study of the Effect of Roller Shape Variations on the CVT System using Petrol-Pyrolytic Fuels toward the Power Characteristics of Automatic Motorcycles

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ABSTRACT

There are two types of two-wheeled vehicles when viewed from the transmission system: manual and automatic. The automatic transmission circuit on the automatic motor, the roller (ballast), is on the primary pulley. In the market, various rollers (weights) are sold, starting from those that are standard and different from the standard with lighter or heavier weight variations. However, there are also aftermarket rollers produced in several automotive industries, one of which is UNIONMATERIAL. The difference lies in the shape and materials used. This study aims to analyze the effect of variations in the shape of the roller on the characteristics of power transmission on automatic motorcycles. The type of vehicle used is a motorcycle produced in 2009 using a dyno test test with two test methods. The first test is from low engine speed ± 1400-1600 rpm to 9000 rpm, while the second test is from medium engine speed ± 4000 rpm to 9000 rpm. In addition, the fuel consumption test was also carried out. The variation used is a roller shape consisting of a round roller, a sliding roller, and a flying roller weighing 12 grams. The highest results obtained at a power of 0.7 HP occurred on the flying roller with 7.1 HP/ 3916 rpm, while the torque was 5.19 N.m on the flying roller (23.96 N·m/1250 rpm). There is an effect on fuel consumption, but not too significant. The biggest difference occurred in the engine parameter RPM 5000 of 0.1 between the flying roller (0.9 L/h) and sliding roller (0.9 L/h) with the round roller (1 L/h) - this happens because the shape of the flying roller is not cylindrical and more dynamic, which is adapted to the movable drive face. There is an additional wing on the roller weight. The data from the results of this study have implications for increasing vehicle performance without changing engine capacity, which requires large costs.

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1. Introduction

Continuously Variable Transmission (CVT) has recently aroused great interest in the automotive sector because of its potential for better emissions and performance [1]. Continuously Variable Transmission (CVT) is a renewable transmission technology that continues through the development and improvement of gear-type transmissions. This improved fuel economy and vehicle acceleration performance by enabling a better match between engine condition and driving mode [2,3]. There are many types of CVT designs, and each design has its characteristics, such as Belt CVT, Spherical CVT [4], Hydrostatic CVT [5], E-CVT [6], Toroidal CVT [7], Power-Split CVT [8], Milner CVT [9], Ball-Type Toroidal CVT [10], and so on. However, of all these types, chains and belts are the most widely used in the automotive world [11]. The application of a belt-type CVT automatic transmission into the motorcycle powertrain system has improved the rideability of this convenient transportation machine [12]. Although the mechanical efficiency of the rubber belt CVT is still unsatisfactory, its simple mechanism and low price characteristics have made motorcycles highly competitive in the automotive motorcycle market [13]. The weakness of the automatic transmission is that the power produced is lower than the manual transmission [14].

Performance is always related to power and torque, power is the amount of effort the engine gets per unit time or can be interpreted as the engine's work rate. Torque can be interpreted as a force that moves at a moment distance and, when equated with work, can reach its purpose [15]. It is necessary to change the engine, which requires a lot of money to change the power and torque. Performance can be circumvented by maximizing power and torque in the CVT (Continuously Variable Transmission) system, which will be forwarded to the wheels from the engine, causing different motor characteristics [16]. One of them is changing the shape of the automatic motorcycle roller. The roller itself on the CVT functions as an outward pressure on the roller housing to change the v-belt's diameter.

In other previous research, it was said that changing the roller weight variable affects the power generated by the engine, which is the highest power produced by the 16-gram roller weight. The torque produced is obtained using a roller weight of 8 grams [17]. In another research, it was also said that the use of a flying roller is an effort to increase power and torque and is very useful in driving a centrifugal pump on a motorcycle fire engine, with the consequence that the effect produced by a flying roller weighing 10 grams on the engine still requires further research [18]. However, the treatment method by varying the shape of the roller still needs to be done because it focuses on variations in weight, pulley angle, and even changing engine capacity. Aftermarket products provide several forms, including round rollers, sliding rollers, and flying rollers. So, in this study, three variations of roller shapes were tested on the performance aspect to determine the effect of variations in roller shape on the characteristics of power transmission on automatic motorcycles. This research has advantages in terms of efforts to improve the performance of automatic motorcycles at an affordable cost.

2. Material and Methodology

In this study, plastic waste consisting of LDPE types were used as fuel for pyrolisis. First, the sample was dried with the sun for 4–5 h to reduce its moisture content and increase its combustible ability. Pyrolytic fuels was conducted to determine the properties used a laboratory apparatus as shown in Table 1. The laboratory test consist of chemical and physic analysis of samples based on ASTM standards. Then it was weighed according to the pyrolysis reactor's capacity, which was 5 kg during the preheating and testing stages.

Table 1
Pyrolytic fuel properties

Properties	Values	Standard Reference
Cetane number	60,1	ASTM–D 2699
Viscosity	1,25 M.Pa.s	ASTM–D 2983-09
Water content	0,0278%	SNI 7182:2015
Specific weight	0,8707 gr/mL	SNI 7182:2015

In this study, an experimental method was used. This study was conducted to analyze the effect of variations in the shape of the roller on the CVT (Continuously Variable Transmission) system on the characteristics of automatic motorcycle power transmission. Testing of 2009 motorcycle with vehicle code NC11B1C A/T assisted by dynamometer test equipment. The schematic of the power and torque test device is shown in Figure 1: (1) Dynamometer, (2) Motorcycle, (3) Engine, (4) Computer, (5) Tachometer, (6) Torsiometer.

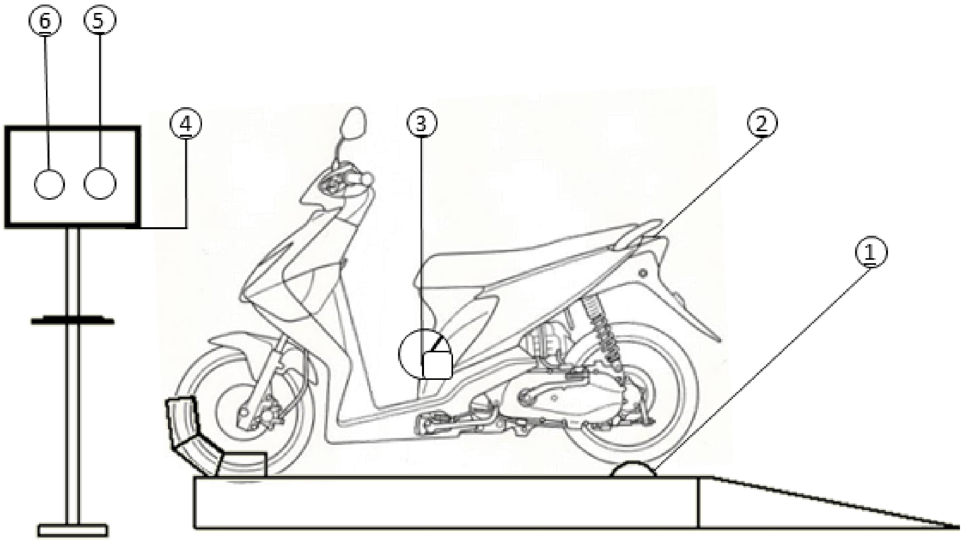

Fig. 1. Schematic of the power and torque test device on a motorcycle

The variation used is a roller shape consisting of a round roller, a sliding roller, and a flying roller weighing 12 grams and using two test methods by spontaneously gassing. The first test is from low engine speed ± 1400-1600 rpm to 9000 rpm, while the second is from medium engine speed ± 4000 rpm to 9000 rpm. The test variations are in Table 2.

Table 2
Variations in the testing process using the dyno test

No	Testing Method	Test 1st	Test 2nd	Test 3rd
1	Low to high engine speed (± 1400-1600 rpm to 9000 rpm)	Round roller 12 grams	Sliding roller 12 grams	Flying roller 12 grams
2	Medium to high engine speed (4000 rpm to 9000 rpm)	Round roller 12 grams	Sliding roller 12 grams	Flying roller 12 grams

Table 3
Fuel consumption test

n	Test 1st	Test 2nd	Test 3rd
2000	Round roller 12 grams	Sliding roller 12 grams	Flying roller 12 grams
3000	Round roller 12 grams	Sliding roller 12 grams	Flying roller 12 grams
4000	Round roller 12 grams	Sliding roller 12 grams	Flying roller 12 grams
5000	Round roller 12 grams	Sliding roller 12 grams	Flying roller 12 grams

Tests are also carried out on fuel consumption using a tachometer and buffet or measuring cup. The tachometer measures the engine speed ratio (rpm) by scanning the ignition magnet, which rotates integrated with the crankshaft rotation. The measuring cup or burette measures the fuel the engine consumes based on engine speed. The following is a table of variations used when taking fuel consumption data with a fixed variable consumption volume (V_f) of 5 ml and a variable time (t).

3. Result and Discussion

3.1. First Testing for Pyrolytic Fuels and Petrol in Engine Simulator

Based on the results of the tests carried out, the influence on fuel consumption on motorbikes can be seen in Table 4.

Table 4
Fuel Consumption Testing Results

Fuels	Engine Rotation (rpm)	Fuels Consumption Testing					
		Engine Temperature (^{0}C)	Time Duration (minute)	Result (ml)			
				Test 1	Test 2	Test 3	Average
Patrol Fuels	3000	69^0	1	6	7	6,5	6,5
	1500	51^0	1	5	3	3	3,6
Pyrolytic Fuels	3000	69^0	1	6	7	9,5	7,5
	1500	51^0	1	5	5	7	5,6

3.2. Power Characteristic of Roller Type on Engine RPM Variations

Figure 2 shows a comparison graph of the power of the round, sliding, and flying roller from low to high engine speed. The results of the dynotest test show that the flying roller has the highest maximum power of 7.1 HP at 3916 rpm engine speed. Then followed by a sliding roller with a maximum power of 6.6 HP at 4345 rpm engine speed and 6.4 HP at 4442 rpm engine speed for the round roller.

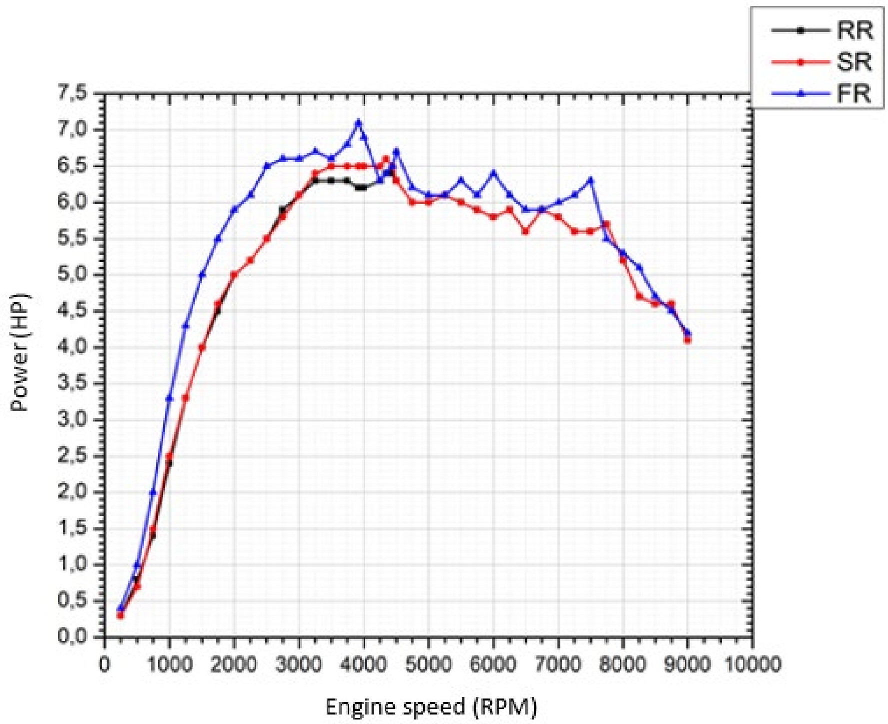

Fig. 2. Comparison Graph of Round Roller Power, Sliding Roller, and Flying Roller of Low Engine RPM

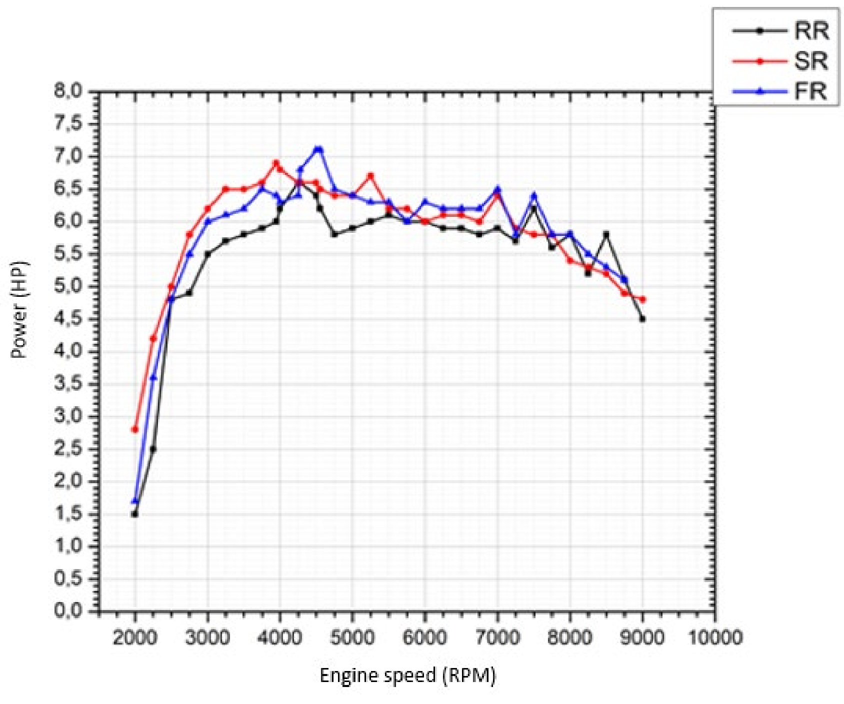

Fig. 3. Comparison Graph of Round Roller Power, Sliding Roller, and Flying Roller of Medium Engine Speed

In the second test with the test method from medium to high engine speed, for the power shown in Figure 3, it can be seen that the highest power is produced by the flying roller of 7.1 HP at 4551 rpm, followed by a sliding roller of 6.9 HP at 3945 rpm. A round roller of 6.6 HP at 4278 rpm engine speed. Based on the two tests, the power generated between each roller type is different. In the first test, the flying roller was superior to the other two types of roller weight. The difference in power generated is 0.5 HP with a sliding roller and 0.8 HP with a round roller. Then, in the second test, the flying roller outperformed the other types, with a power difference of 0.3 HP with a sliding roller and 0.5 HP with a round roller. The difference in result is high enough to replace a roller weight - this shows that the power generated by the flying roller is better when compared to the other two forms of rollers.

The identical previous research states that by utilizing an automatic motorcycle as the main driver of a centrifugal pump on a motorcycle fire engine, replacing the flying roller to increase engine power and torque is very useful [18]. This change occurs because of the difference in the shape of the roller weight itself. The shape of the flying roller is not cylindrical but more dynamic, adapted to the roller housing (movable drive face), which functions to fill gaps and reduce noise. There is an additional wing (wing) on the roller weight, which prevents the roller weight from tipping over.

Meanwhile, in other research, it is said that changing the roller weight variable affects the power generated by the engine; the 16-gram roller weight produces the highest power. The torque produced is obtained using a roller weight of 8 grams [17]. In this research, variations were only made on the weight of the roller so that the greatest power produced occurred at the lightest roller weight, which was 8 grams. Unlike what the author did, variations were made to the shape of the roller weight, with the weight of each roller weight being the same, namely 12 grams.

3.2. Result Comparation of Roller type Torque on Engine RPM variations

The results for the torque itself are shown in Figure 4. In the testing method from low to high engine speed, the flying roller produces the highest torque of 23.96 Nm at 1250 rpm engine speed, followed by sliding roller and round roller with the results obtained respectively 19 .07 Nm at 1360 rpm engine speed and 18.77 Nm at 1500 rpm engine speed.

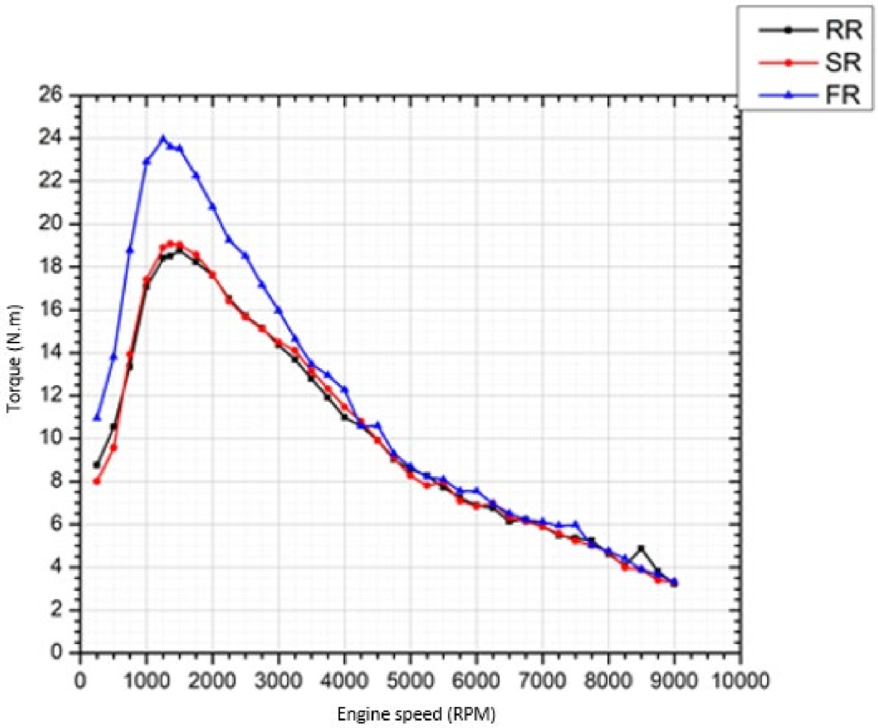

Fig. 4. Torque Comparison Graph of Round Roller, Sliding Roller, and Flying Roller from Low Engine Speed

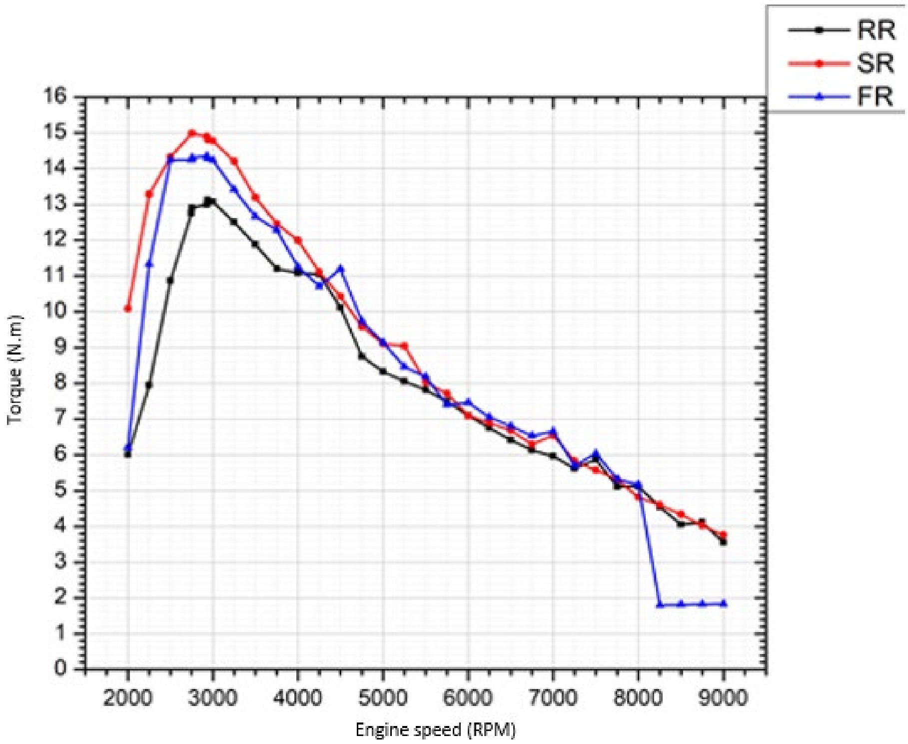

Fig. 5. Comparison Graph of Round Roller Torque, Sliding Roller and Flying Roller from Medium Engine Speed

The torque generated in the second test with engine speed from medium to high is shown in Figure 5. The sliding roller produces the highest torque of 14.98 Nm at 2927 rpm engine speed, followed by a flying roller of 14.35 Nm at 2754 rpm engine speed and the last round roller with the results obtained of 13.12 Nm at 2938 rpm engine speed. Based on the two tests, there is a difference in torque produced between each type of roller. In the first test, the flying roller still got the highest results with the resulting torque difference of 4.89 Nm with the sliding roller and 5.19 Nm. As for the second test, the sliding roller is slightly superior to the flying roller of 0.63 Nm, and the difference is 1.8 Nm with the round roller. The difference resulting from the change in the shape of the roller weight is quite significant, especially in the first test.

Based on other previous research, which states that using an automatic motorcycle as the main driver of a centrifugal pump on a motorcycle fire engine, replacing the flying roller to increase engine power and torque is very useful [18]. This change occurs because of the difference in the shape of the roller weight itself. The shape of the flying roller is not cylindrical and is more dynamic, adapted to the roller housing (movable drive face). An additional wing on the roller weight, as shown in Figure 2.8, prevents the roller weight from tipping over. While on the sliding roller, there is no wing, so the position of the roller weight can still move on the roller housing, although the shape of the roller weight is not much different from the flying roller.

Meanwhile, another research found that changing the roller weight variable affects the power generated by the engine, the highest power produced by the 16-gram roller weight. The torque produced is obtained using a roller weight of 8 grams [17]. In this study, only variations were made on the weight of the roller weight so that the largest torque produced occurred at the lightest roller weight of 8 grams. Unlike what the author did, variations were made to the shape of the roller weight, with the weight of each roller weight being the same, namely 12 grams.

Figure 6 shows a graph comparing fuel consumption between round rollers, sliding rollers, and flying rollers at engine speeds of 2000 rpm to 5000 rpm. In the engine parameter of 2000 rpm, the lowest consumption is generated by the flying roller of 0.29 L/h, followed by the sliding roller of 0.3 L/h and the round roller of 0.33 L/h. The difference produced by the flying roller is small, only 0.01 with a sliding roller and 0.04 with a round roller. Likewise, the resulting difference is manageable for the next engine RPM parameter; the biggest difference occurs in the RPM 5000 engine parameter of 0.1 between flying roller (0.9 L/h) and sliding roller (0.9 L/h) with the round roller (1 L/h). The resulting difference is not too significant, considering that the variations used only in rollers do not change the weight, so the engine load remains the same.

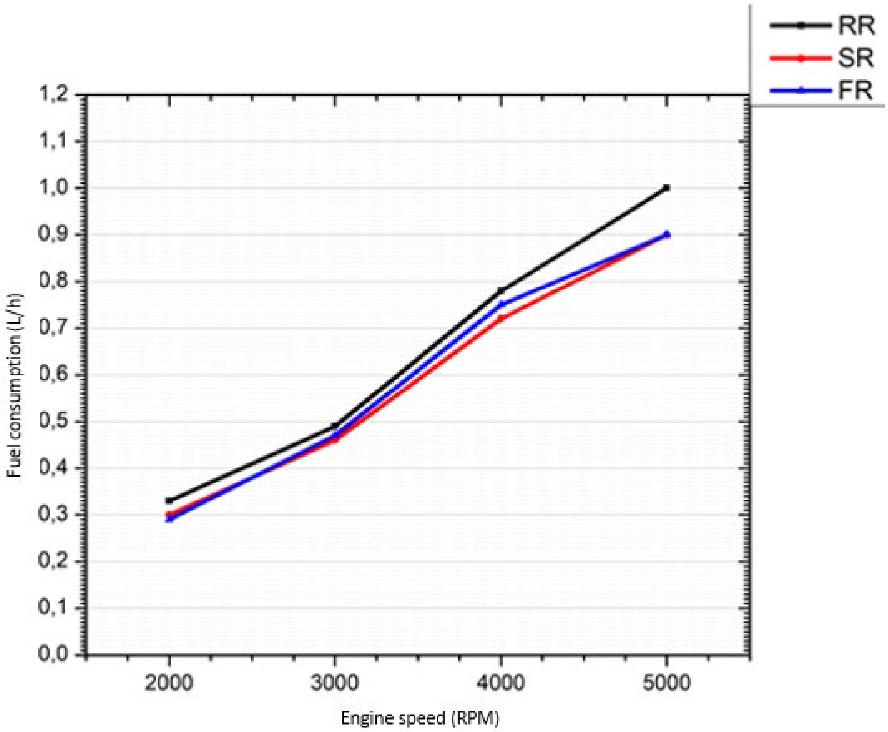

Fig. 6. Graph of comparison of fuel consumption between round rollers, sliding roller and flying roller

Based on other previous research, it was said that the fuel consumption (F_C) test results concluded that the 10gr and 13gr rollers have almost the same fuel consumption at 3500 rpm and 4000 rpm. In contrast, the 14gr roller has the highest fuel consumption compared to the 10gr and 13gr rollers at 2000 – 4000 rpm [19]. In this study, variations in weight were carried out; there were differences at 2000 rpm to 4000 rpm and no difference at 3500 rpm and 4000 rpm-this happens because of the -variations used in the weight so that it changes the engine load even if only a little. In contrast to the research, the variation is done on the shape.

Another study also explained that there was an effect on the specific fuel consumption of motorcycles with the use of variations in the weight of rollers and sliding sheave springs, the most economical fuel consumption from low to high revolutions with the use of variations in the weight of rollers 11 grams and springs 2.45 N/mm has a specific fuel consumption of 0.095 kg/kW·hour, compared to the use of roller weight variations and other values of spring constant. This study has an effect on fuel consumption due to the variations used on the roller's weight and the spring constant. In contrast to the research, the variation was carried out in the form [20].

4. Conclusions

Based on the results of testing the effect of variations in the shape of the roller on the characteristics of power transmission toward automatic motorcycles with vehicle code NC11B1C A/T, it can be concluded that there is an effect on the characteristics of power transmission. The power generated by using the flying roller has a difference of 0.7 HP with the round roller at 3916 rpm (7.2 PS). The increase occurred by 9% after automatic motorcycles experienced a 21% decrease in performance. In other words, using flying rollers increases performance from 79% (6.5 PS) to 88% (7.2 PS). There is an effect on torque; the round roller's torque is initially 18.77 N·m at 1500 rpm. The increase in torque is 5.19 N·m on the flying roller (23.96 N·m/1250 rpm) and 0.3 Nm on the sliding roller (19.07 N·m / 1360 rpm). There is an effect on fuel consumption, but not too significant. The biggest difference occurred in the engine parameter RPM 5000 of 0.1 between flying roller (0.9 L/h) and sliding roller (0.9 L/h) with round roller (1 L/h). Furthermore, the consumtion rate of pyrolytic fuels more than patrol fuels it is due to the characteristic. However, this method can be chance to develop alternative fuels for reducing gas emission from vehicles.

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