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Analysis of the use of needle thrust bearings in CVT springs on torque and power on motorcycles

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Abstract

Several studies have been conducted on methods to enhance the torque and power output of automatic motorcycles. An intriguing addition to the Continuously Variable Transmission (CVT) spring is the incorporation of a needle thrust bearing. Further investigation is required to examine the effects of employing needle thrust bearings on CVT springs on the torque and power of automatic motorcycles. The research seeks to quantify the effect of incorporating Needle Thrust Bearings into motorcycle CVT springs on the generated torque and power. A study was conducted to determine if the inclusion of the needle thrust bearing component has a substantial impact on the motorcycle's torque and power. Experiments were conducted using a Super Dyno 50L, a Dyno testing instrument manufactured by the brand Dyno. The test was conducted thrice, with careful consideration given to the engine's rotational speed (rpm) as a benchmark. The test results indicate that the utilization of Needle Thrust Bearings on CVT springs leads to an average torque increase of 5.32% and an average power increase of 5.84% compared to without the use of Needle Thrust Bearings on CVT springs.

Keywords

Needle thrust bearings, CVT springs, Motorcycles

Introduction

The Central Statistics Agency (BPS) will release the 2023 Indonesian statistics report by the end of 2022, which states that there will be approximately 125.3 million motorcycle units in Indonesia. Between 2012 and 2022, the country experienced a significant growth in the number of motorcycles, reaching approximately 48.9 million units, which represents a 64% increase [1]. The information will be presented in a more comprehensive manner in Figure 1.

This particular variant of self-propelled two-wheeler is widely favored by the majority of individuals residing in Indonesia [2]. Agen Tunggal Pemegang Merek (ATPM) offers a variety of automatic motorcycles, including one type with an engine capacity exceeding

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150 cc [3]. The majority of individuals in Indonesia have a strong preference for this particular model of self-operating motorcycle [2]. Engine capacities exceeding 150 cc are believed to sufficiently meet the public's demand for transportation power [4]. Figure 2 illustrates various models of 150cc Automatic Motorcycles commonly employed in Indonesia.

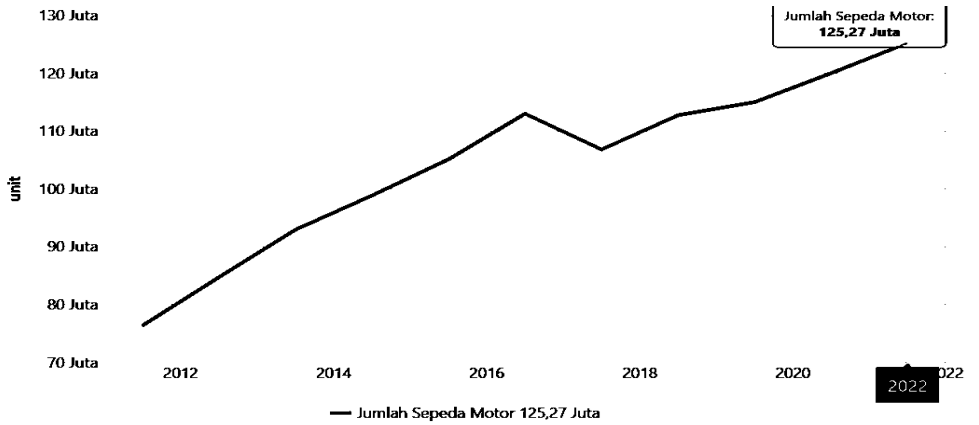

Figure 1. Graph Amount Motorcycle in Indonesia

Figure 2. Several types of 150cc automatic motorcycle

Many Indonesians believe that the torque and power of a motorcycle in the 150cc class (150 cc) are not yet at their best. Consequently, they seek to enhance the vehicle's torque and power by adding supplementary components [5][6][7][8]. Several studies have been conducted to explore methods for enhancing torque and power. This can be achieved by modifying or adjusting the rollers on the Continuously Variable Transmission (CVT) [9]. In addition, several modifications were made to the CVT springs [10]. A seldom conducted research involves the utilization of a needle thrust bearing positioned on a CVT spring [11]. The inclusion of the needle thrust bearing is intended to enhance the compression force exerted by the CVT spring, thereby augmenting the torque and power output of the motorcycle. The application of resistance to the CVT spring results in an elevation of pressure on the sliding sheave located on the secondary pulley. A Needle Thrust Bearing is a bearing that comprises a needle and a cage-shaped guide. A Needle Thrust Bearing is a circular disk-shaped component designed to exclusively withstand loads in a single predetermined direction [12]. This bearing is ideal for applications that necessitate space optimization due to its low-profile design and ability to withstand substantial loads. During the installation process, the Needle Thrust Bearing is positioned on the shaft or any other surface that serves as a support for the

bearing [9]. According to the attributes specified in TABLE 1 for the 155cc motorcycle. This motorcycle is equipped with a Liquid Cooled 4-stroke, Single Overhead Camshaft (SOHC) engine, with a cylinder capacity of 155cc. It generates a peak torque of 14.4 Nm at 6,000 rpm and a maximum power output of 11.1 Kw at 8,000 rpm. This study aims to investigate the impact of incorporating Needle Thrust Bearings on the torque and power output of motorcycles.

Method

Following is the specification of the motorbike that became the object study specification motorcycle. The installation of a needle thrust bearing is performed for the vehicle models listed in Table 1. Figure 3 depicts the configuration of a needle thrust bearing and its utilization in a motorcycle CVT.

Table 1. Specification Motorcycle

	Machine
Type machine	: Fluid-cooled 4-stroke, SOHC
Amount/cylinder position	: Bachelor Cylinder
Capacity machine	: 155cc
Diameter X step	: 58.0mm x 58.7mm
Comparison compression	: 10.5: 1
Power maximum	: 11.1 kW/8000 rpm
torque maximum	: 14.4Nm/6000rpm
System starter	: Electricity Starter
System lubrication	: Base
Capacity oil machine	: Total – 1.00 L; Periodic – 0.90 L
System material burn	: FI (Fuel Injection)
Type Stove	: 11.0: 1
Type Transmission	: V-belt Automatic

Figure 3. Needle thrust bearing and the application of its addition to a motorcycle CVT

Static analysis

The study will be conducted using Dyno test equipment. The Dyno test tool used is the Super Dyno 50L, produced by the Bintang Racing Team. The Super Dyno 50L has the capacity to measure a maximum of 100 horsepower during the dyno test of the machine. Furthermore, this machine operates efficiently with a power consumption of only 100 watts. The testing was conducted three times with equal frequency, specifically focusing on the engine's revolutions per minute (rpm), torque, and the analysis of generated power using statistical formulas. The percentage was calculated using Equation (1).

$$P = \frac{n-N}{n} \times 100\% \qquad (1)$$

Where: P is Test percentage value, n is without needle thrust bearing, and N is with needle thrust bearing

Result and Discussion

Result data

The results of torque and power testing are shown in Table 2, conducted without utilizing the specified configuration. The first vehicle was tested without the use of Needle Thrust Bearings, while the second vehicle had the Needle Thrust Bearings installed to enhance its performance.

Table 2. Torque and Power result test

Condition	Test 1	Test 2	Test 3
Without Needle Thrust Bearing (Torque)	12.32 Nm	12.48 Nm	12.62 Nm
Using Needle Thrust Bearings (Torque)	12.82 Nm	13.05 Nm	13.67 Nm
Without Needle Thrust Bearing (Power)	8.75 Kw	9.03 Kw	9.92 Kw
Using Needle Thrust Bearings (Power)	9.47 Kw	9.81 Kw	10.12 Kw

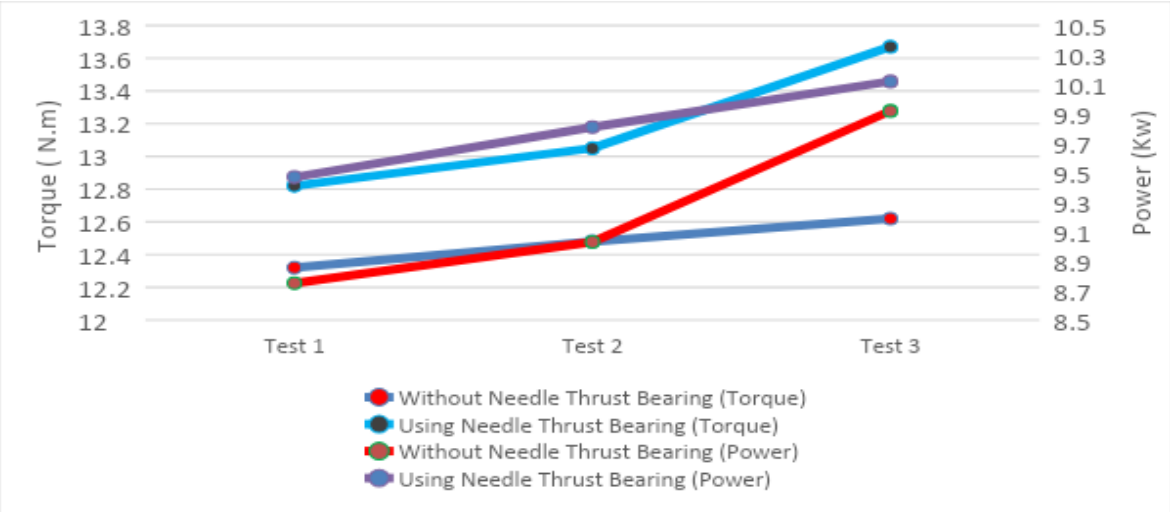

Figure 4. Results Torque and Power tests

The data presented in Table 2 pertains to the torque and power testing of a vehicle in two different conditions: one without a needle thrust bearing (referred to as the standard vehicle) and another with the inclusion of a needle thrust bearing. According to the data, motorcycles that have Needle thrust bearings experience a notable boost in torque generation when compared to standard conditions. The test results indicate that the torque experienced a growth of 3.90%, 4.36%, and 7.68% in the first, second, and third tests, respectively. The mean increment amounts to 5.32%. Likewise, the motorcycle demonstrates identical patterns in power generation. The data shows that the first test had a power increase of about 7.60%, the second test had a power increase of about 7.95%, and the third test had a power increase of about 1.97%. On average, there

was a power increase of 5.84%. The results of the torque and power tests carried out can be seen in Figure 4.

Conclusion

The statistical analysis indicates that investing in results analysis testing for Torque testing leads to a significant increase in torque, with an average increase of 5.32%. The test yielded a power exertion that led to a 5.84% increase in average power. By incorporating a needle thrust bearing into a continuously variable transmission (CVT) motorcycle, the torque and power of the motorcycle will be enhanced.

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