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An analysis of the efficiency of two-wheelers powered by continuously variable transmissions in the face of a failing centrifugal clutch

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Abstract- In the current climate, a 150cc 4-stroke gasoline engine with a gearbox achieves around 15% better fuel efficiency than a CVT basic gearless two-wheeler. In India, the market for gearless two-wheeler scooters is around 5 million units annually. Petrol quality, road load condition, driving circumstances, vehicle load loading, and driveline type are the most important variables affecting fuel efficiency, according to an analysis of pertinent tests and real-time data. Continuously variable transmissions (CVTs) are the foundation of current two-wheeler scooter transmission systems, which use a dry centrifugal clutch. A consistently variable gearbox (CVT) that is mechanically based has three main components: a driven pulley that detects torque, a driving pulley that senses speed, and a V-type rubber belt that connects them. During operation, the driven and driving pulleys are subjected to axial stresses and torque. The essential component of a CVT for torque transmission is a dry centrifugal clutch. There are three possible states for a dry centrifugal clutch: fully engaged, partially engaged, and sliding. Consistent, moderate driving changes the properties of the dry centrifugal clutch, which impacts the power gearbox and fuel efficiency. In this work, we use an experimental foundation approach to find out how fuel economy changes as a result of clutch characteristics gradually degrading.

Keywords – Fuel economy, centrifugal clutch, two-wheeler

INTRODUCTION

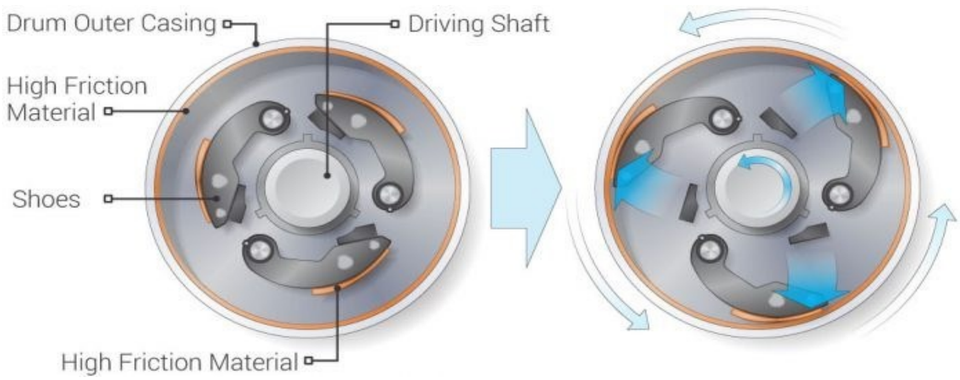
CVT (Continuously variable transmission)

Automatic gearboxes with a continuously variable gearbox (CVT) may shift smoothly through an infinite number of gear ratios. This is in contrast to other gearboxes that provide a set number of gear ratios. With the right kind of management, a continuously variable gearbox (CVT) may be able to keep the engine running at a constant RPM even when the vehicle's speed is constantly changing. Vehicles, tractors, motor scooters, snowmobiles, and construction equipment all make use of continuously variable transmissions. Two pulleys linked by a belt or chain comprise the most typical CVT, which employs a dry centrifugal type clutch.

Dry Centrifugal clutch

A centrifugal clutch is a clutch that uses centrifugal force to operate. The output shaft is disengaged at low rotational speed and engages more as speed increases. It is often used in mopeds, under bones, lawn mowers, go-karts, chainsaws, mini bikes, and some parameters and boats to keep the engine from stalling when the output shaft is slowed or stopped abruptly, and to remove load when starting and idling. It has been superseded for automotive applications by the fluid coupling. [12]

burn a lot of power.



Clutch that spins (Fig.1) [12] Manipulating the brake One end of the clutch is connected to the pulley that the CVT turns, while the other end may be utilised to drive a belt, chain, or shaft. As the input shaft revolutions per minute increase, the clutch engages by means of the forward movement of the clutch's weighted arms. Most often, radially placed shoes or friction pads make touch with the inner rim of a housing. Several extension springs are attached to a clutch shoe and fixed on the centre shaft. When the central shaft rotates quickly enough to extend the springs, the clutch shoes make contact with the friction face.

Problems with centrifugal clutch
A certain amount of power can only be transmitted by the centrifugal clutch before it slips.
A centrifugal clutch isn't very effective at producing torque. The centrifugal clutch's ability to transmit torque drops sharply when the applied load gets close to its limit; the clutch only engages when the engine reaches a certain angular speed; and friction and slipping

Next, we will go over the literature. Dhruv Panchal et al. found that a worn clutch friction liner and rubber belt significantly impact the fuel economy of a CVT-driven scooter [1]. The clutch friction liner contributes to the decrease in fuel efficiency to an extent of Analysis of variance was used to assess the impact of components and interactions on the root cause, and the results showed a contribution of 62.40%. Rubber belts provide 31.16 percent, whereas CVT fly masses contribute 1.87%. As a result of doing theoretical research on the interaction between the rubber belt and clutch friction liners, it is possible to anticipate their combined influence. It is feasible to improve the specifications of a CVT-driven scooter so that it maintains its fuel economy by determining what primarily causes the friction liner and rubber belt to wear down. According to the results of the models used by C. H. ZHENG et al. [2], the radius of the driven pulley increases as the torque applied to the CVT output shaft increases, provided that the friction coefficient between the belt and the driven pulley remains constant. The CTCF (Coefficient of Torque Capacity Factor) was

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also developed to augment the general economy of vehicles equipped with CVTs. With an ideal CTCF, the power source may stay within its efficient working range, with those ranges defined by the CTCF value.

A study conducted by C. ZHU et al. [3] suggests that tweaking variables including engagement speed, shift speed, load condition, ratio range control, and CVT components might lead to improved efficiency. Using a high-elastic-modulus belt or fine-tuning the belt tension in combination with a complicated multi-angle torque cam, axial pressure control, and shims calibrated on a secondary pulley may greatly improve the efficiency of a rubber V-belt continuously variable gearbox (CVT). When a high-strength belt is developed and structural improvements are made to the driven and driving pulleys, the rubber belt CVT will also find further applications in vehicles.

Clutch tests were conducted by Tse-Chang Li et al. [4] to ascertain the greatest temperature rise and p*/p value that could be achieved with the specimens. For specimens with large maximum p*/p, the maximum temperature rise was usually quite small. A greater maximum p*/p and a larger dμ/dVx often result in stronger judder in specimens. These findings indicate that the moulding pressure of the frictional lining is the most influential of the three objective functions. With the highest value and strongest correlation to maximum profitability among the five control factors, moulding pressure stands out. Finding the desired thermal effect is dependent on the air flow guide, as shown in the study by N. Karthikeyan et al. [5]. The intake side of the clutch housing is equipped with an axial guide to enhance the flow. The output area is up 184% and the clutch housing flow is up 40%. A temperature reduction of 8 degrees Celsius occurs on the clutch surface between the first and final designs.

Oday I. Abdullah et al. [6] found that the disc's outer radius is the site of maximum contact pressure and the inner disc radius is the site of minimum penetration. There is very little slip between the clutch components due to the extreme strain they are under, leading to the generation of contact friction stresses. Contact friction stresses are greatest at the outer and inner disc radii and least at the clutch disc's mean radius. Think about how the distribution of contact pressure and the actual contact area would change if the clutch's contact surfaces had thermal cracks and persistent deformations.

Tests conducted by Sujit Mohire et al. [7] on rigs based on RLD schedules using energy dissipation theory indicate that it provides a quicker method to assess clutch life. The testing method shows a good correlation with real-world data for wear rate and friction lining condition. In the case of certain field usage scenarios, the same method might be used effectively to assess clutch failures. It is necessary to collect RLD under abusive conditions in such a case. By using the proposed method, the test rig may be used to mimic a failure scenario. Any clutch design change to address a specific field issue with clutch friction life may be tested on the test rig using the proposed method.
As to Vivek Adyanthaya et al. [8], a CVT Test Rig enabled the researchers to examine the transmission's characteristics and precisely measure its efficiency in various driving modes. This continuously variable gearbox (CVT) was fine-tuned by adjusting the driving

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spring, helical ramp of the torque sensor, roller track angle and centrifugal roller weight. While operating at WOT, this resulted in enhanced acceleration and tractive effort on wheels, and while operating at half throttle, it achieved exceptional fuel economy owing to lower engine speeds.

Based on the study conducted by E. Humphrey et al. [9], the kinetic coefficient of friction for the clutch friction lining material in contact with the sinusoidal wavy and rough surface of the pressure plate falls as the contact temperature rises and the slip speed increases. The clutch and plate are also lined with this material. Clamping forces increase the coefficient of friction, which deforms surfaces to make them smoother, but they reduce traction. Results from experiments support these contact characteristics, which are consistent with tractive contact mechanics, such as creep under slip situations. Moawad A. et al. [11] discovered that the amount of shifting occurrences is a critical feature for properly estimating fuel use. It seems to reason that more shifting events would lead to less fuel usage, as gearboxes primarily aim to maximise engine efficiency. A lot of people have been talking about this for Engineers improve engine operating conditions by continually altering the ratios of continuously variable transmissions (CVTs), which might contribute to substandard driving performance. The automotive business must proceed cautiously when determining the relative importance of fuel efficiency, ride quality, and the advantages of a greater number of changing events.

The study by Robin TEMPORELLI et al. [10] on the advantages of electrifying an RV's clutch is shown by this power use comparison. If we compare the power consumption of the new electromechanical technology with that of the old hydro-mechanical technology, we can see that the latter consumes much more energy. The low energy consumption of electromechanical technology is most noticeable during the steady phase, which is the most usual operating phase of a vehicle's clutch. In conclusion, WMTC 3.2 indicates that a recreational vehicle's fuel consumption might be 6.2% lower with an electronic clutch.

CONCLUSION

According to studies, scooters that use continuously variable gearboxes lose around 37% of their fuel economy after a certain amount of time on the road. Given the millions of used scooters on the road, it is necessary to estimate the contribution of major factors to the decline in fuel economy.
It is possible to improve efficiency by modifying the CVT's components, altering the engagement and shift speeds, controlling the ratio range, and taking the load condition into account.
A worn-out rubber belt and clutch friction liner significantly impact the fuel economy of a scooter driven by a continuously variable transmission. Which may be rectified employing a number of techniques that need to be explored. Determining the reasons of clutch deterioration and implementing optimisation methods is crucial for preserving and improving fuel efficiency.

It is possible to improve fuel economy by modifying the centrifugal clutch and continuously variable transmission.

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